Facial composition, body language, and interpersonal judgements: individual differences in partner choice.

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Facial composition, body language, and interpersonal judgements: individual differences in partner choice.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee.

I declare that the Word Count of this Thesis is 44476 words.

Name:

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Abstract

Background and Objectives: Human mate choice is a complex, multi-faceted area of research. This thesis aims to investigate the contested relationship between facial appearance and fathering ability, based on the idea that women make a trade-off between a partner with good genes, and someone who will invest in the offspring. Additionally, a further investigation into sexual disgust at the prospect of mating with kin, with self-similar male faces as a proxy, to observe the Westermarck effect in action. The similarity of couples in appearance, personality, and genetics has been well documented, but less known is the similarity of body language of couples, and if they can be differentiated from pairs of strangers. Finally, a look into imprinting-like mechanism upon parental eye colour across individuals dating histories, as well as seeing if there is a self-similar preference for eye colour.

Methods: Innovative technology is mixed with traditional survey methods (Chapters 5 and 6) in this thesis, including facial measurements and facial morphing (Chapters 2 and 3), electromyography measuring disgust (Chapter 3), and motion capture (Chapter 4).

Results and Conclusions: We found that masculine fathers are not worse fathers, and that perceived masculinity has no association with structural masculinity in our sample, that self-reported disgust supports the Westermarck hypothesis that cues of kinship are unattractive after *some* similarity. We also found that couples move differently to strangers and can be identified as such, that individuals do not appear to actualise eye colour preference in dating partners, and that same-sex parent matching occurs more than opposite-sex parent eye colour matching.

It is clear that there is much work still to do to disentangle the evolutionary aspects of human mate choice, but the use of novel methodology in this thesis adds further knowledge and clarity to some contentious areas of research, as well as new avenues.

Additional Information

All data and R analysis can be found at the following link:

https://osf.io/45fxg/?view_only=9aae510beec144a1b785ef9066685b28.

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Clear eyes, full hearts, can't lose.

Introduction

Whilst man, however well-behaved, at best is but a monkey shaved!

W.S. Gilbert (1884)

Natural Selection

When Charles Darwin (1859) proposed his theory of natural selection, it irrevocably changed science. Darwin posited that species and traits evolved over time as an adaption to environmental pressures due to natural variation. Heritable traits that were beneficial to the species regarding survival and reproduction were passed on to the next generation. For example, cheetahs (*Acinonyx jubatus*) are naturally bred for speed, resulting in long legs, small head, and a deep chest. Their speed increases their ability to catch food, which in turn, increases their likelihood of reproductive success. Less able cheetahs (i.e. slower cheetahs, who are less able to catch food) will therefore have less chance of reproducing and passing on their genes. This theory applies to all organisms. Fitter, reproductively successful organisms should pass on those beneficial traits, and maladaptive traits that impact negatively on fitness and reproductive success should be bred out over the generations.

However, Darwin began to notice that some traits did not fit his theory; the males of many species of birds have elaborate crests, bright feathers, or long tails (Manning, 1989). Specifically, the male peacock (*Pavo cristatus)* rattled Darwin. In fact, he wrote, “the sight of a feather in a peacock’s tail makes me sick” (quoted in Cronin, 1991, p113). The sheer size of the male peacock’s tail left him slow, and vulnerable to predators, along with the bright colours leaving him unable to camouflage. This tail, therefore, is cumbersome, and surely would hinder his survival and should have been phased out over the generations if survival pressures were the only ones at play.

Sexual Selection

Survival hindering ornamentation, usually in males, became the basis for the theory of sexual selection, a selection pressure resulting from opposite-sex mate choice (Darwin, 1871). Sexual selection is further broken into intrasexual and intersexual selection: competition *between* same-sex members, and competition to be *chosen* as a mate respectively.

Intrasexually selected traits are thought to have evolved due to selection pressures from same-sex members of the species for access to territory, status, and mates. These traits are known as armaments; essentially weapons of aggression, or signals of dominance. The obvious example would be the antlers that stags (*Cervidae*) develop. The antlers are costly to produce annually (Kodric-Brown & Brown, 1984), with Bubenik (1982) estimating that to produce even a modest set of antlers would require 3-5 times the normal daily amount of calcium and phosphorus intake. Despite the costs, antlers play an important role in male threat displays, and social dominance in stags is demonstrated by the use and development of antlers (Kodric-Brown & Brown, 1984). In turn, this allows the winner access to females, thereby having the opportunity to reproduce. Qualities that are linked to losing in dominance displays will, therefore, fail to be passed on (Buss, 2004).

Intersexually selected traits, however, are thought to provide a cue or signal of physical fitness and represent a good reproductive partner to the 'choosing' partner. In most species, the choosing partner is the female as she has the highest physiological cost of reproduction. Again, the peacock is a key example here: the male peacock's tail is a costly ornament to maintain but is thought to signal his ability to survive, and his physiological condition. Trivers (1972) coined this choosiness, parental investment.

Parental Investment

According to Trivers (1972), the sex with the largest physiological burden regarding reproduction should be the chooser. Females provide the eggs, which are finite and costly to produce. Males produce sperm, which is theoretically unlimited. In humans,

women are born with around 1 million eggs, although only about 300- 400 ova will be ovulated, whereas men can replenish sperm at a rate of approximately 12 million per hour (Buss, 2004). Additionally, the female carries the burden of gestation, and particularly in mammals, nurturing offspring. Gestation and lactation necessitate huge amounts of energy, making the role of the female in reproduction extremely energy demanding. Generally, females bear the greater cost, and therefore do not reproduce indiscriminately- the allocation of these resources are used selectively. Trivers (1972) postulated that the sex that invests more in offspring would be more selective about their mates: poor mates could lead to huge costs. Secondly, the sex that invests less will compete for access to the higher investing sex.

Female Selection Preferences

Male Health Preferences

Mating with a healthy partner is key for successful offspring. Bad genes and lack of health could kill the male prematurely, ending his contribution of resources to the female. Similarly, any disease could be passed to the female, or their offspring, leaving them vulnerable. Thus, our ancestors and animals alike needed a way to signal and cue their quality. Females, as the “choosers”, do not have these signals and cues. Instead, the males who are competing for access display the cues and signals, e.g. many bird species have dull coloured females and brightly coloured males.

Zahavi (1975) suggested that females use the extravagant ornaments of males to judge their genetic quality. These displays are costly; therefore, only males of high-quality genes can afford to produce and maintain these ornaments. Often, research has found a male’s ornament is an honest signal of parasite load, with more vibrant, extravagant ornaments indicating a low parasitic load. By avoiding infected or poor quality males, the female can reduce her risk of disease, and increase her offspring’s chance of survival (Penn & Potts, 1998a). The male benefits by virtue of advertising his quality, and so drawing the attention of more females, increasing his chance of mating (Zahavi, 1975).

Peahens prefer to mate with males with the most extravagant plumage, and so the genetics pass down (Buss, 2004).

Folstad & Karter (1992) suggested the immunocompetence handicap hypothesis (ICHH) as a way of explaining the male sexual ornaments and their interaction with the endocrine and immune systems. Testosterone is known to enhance male secondary sexual characteristics (such as the peacock tail), while simultaneously suppressing the immune system, leaving the male vulnerable to infection and disease. Therefore, only high-quality males can afford to display ornaments without falling prey to parasites and disease (Folstad & Karter, 1992). The ICHH predicts that males have their own optimum level of testosterone, which is high enough to maximise the ornament production, but low enough to minimise the immunosuppression (Roberts, Buchanan, & Evans, 2004). Testosterone increases in moorhens (*Gallinula chloropus*) result in increased thickness, size, and colour of their frontal shields (Eens, Van Duyse, Berghman, & Pinxten, 2000). House sparrows (*Passer domesticus*) with increased testosterone have increased badge sizes (Evans, Goldsmith, & Norris, 2000). In white-tailed deer (*Odocoileus virginianus*), testosterone levels positively correlate with antler size, and with pathogen resistance (Ditchkoff, Lochmiller, Masters, & Hoofer, 2001).

However, the ICHH is controversial in humans. Facial masculinity was considered a sexual cue in men, with high masculinity defined by exaggerated sex-typical features, such as wide cheekbones, prominent brows, and thin lips (Scott, Clark, Boothroyd, & Penton-Voak, 2013). The theory most supported was that such masculinity was linked to good health in men, however, was rarely tested in humans. Studies that looked at perceived masculinity (i.e. subjective ratings by participants) found some positive relationship with testosterone (Pound, Penton-Voak, & Surridge, 2009), while another found evidence of a weak relationship between subjective ratings of masculinity and adolescent health (Rhodes, Chan, Zebrowitz, & Simmons, 2003). When looking at self-reported health, Thornhill & Gangestad, (2006) found a negative relationship between masculinity and past respiratory diseases, while another study found a positive

relationship between testosterone, facial attractiveness and immune function as measured by response to a hepatitis B vaccine (Rantala et al., 2012).

This concept has been called into question in recent years however, with many studies finding no evidence that masculinity is related to health. In a study of 1233 participants, masculinity was found to scale with growth in both men and women, indicating that masculinity is not a male ornament, as ornaments tend to be more sensitive to growth (Zaidi et al., 2019). Further, immunocompetence was not correlated with facial masculinity (Zaidi et al., 2019). More research finds links between facial masculinity and perceived age (Boothroyd et al., 2005), between masculinity and dominance (Boothroyd, Jones, Burt, & Perrett, 2007) - but not perceived or actual health (Boothroyd, Lawson, & Burt, 2009). In fact, one study found that a more masculine facial structure was associated with greater ill health in terms of suffering from the flu (Boothroyd, Scott, Gray, Coombes, & Pound, 2013). Additionally, no relationship was found between androgens and immune functions, and neither total testosterone nor dehydroepiandrosterone (DHEA) showed any immunomodulatory properties in a sample of Western men (Nowak, Pawłowski, Borkowska, Augustyniak, & Drulis-Kawa, 2018). In a non-Western sample, a quadratic relationship was found between the masculinity of father and their offspring's survival, wherein intermediate levels of testosterone were associated with lowest offspring mortality, and high and low levels of testosterone associated with increased offspring mortality (Boothroyd et al., 2017).

Male Investment

As well as healthy mates, females of many species show a preference for resources and social status. The male grey shrike (*Lanius excubitor)* during mating season hunt for snails and useful objects such as cloth in huge numbers, displaying them on thorns in their territory. Females then mate with the male with the largest collections (Yosef, 1991).

In humans, women hold a partner’s earning prospects in high regard (Buss, 1989; Buss et al., 2001; Feingold, 1992; Shackelford, Schmitt, & Buss, 2005), with Buss finding that in 36/37 cultures, women placed more importance on earning potential than men. This

finding holds in more recent work, in which both American and Singaporean women prioritise social status as necessities in their long-term relationships (Li, Valentine, & Patel, 2011). In fact, resources and social status has been identified as a common dimension in most studies, along with family commitment, appearance, and kindness, as one of the most important traits (Shackelford et al., 2005).

The ability to provide resources and social status is indicative of a man's ability to obtain the resources, and his willingness to actually share, leading to the survival of the woman and their offspring (Buston & Emlen, 2003). Social status can be indicative of resources, but also with higher social standing comes more food, more land, and better healthcare, and more opportunities for the children of those with high social status (Buss, 2004).

Male Selection Preferences

Female Appearance

Appearance matters to males. Desirable females are fertile, and as such, cues to fertility are attractive to males. In humans, women's fertility decreases from around the age of 30 (Buss, 2004), leading to a preference for youth in a woman. Men preferring a younger partner appears to be universal across cultures. In each of the 37 cultures investigated, men prefer women who are younger, in both monogamous and polygamous societies (Buss, 1989). The authors found a preferred age difference of 3.04 years, which equated to actual ages at marriages, in which the age difference was 2.99 years between spouses. This desire for a younger partner increases as men age: men in their thirties prefer an age gap of around five years, while men in their fifties prefer an age gap of around 10-20 years (Kenrick & Keefe, 1992).

Physical appearance often signals youth and fertility and is attractive to men. Cues such as clear skin, shiny hair, healthy teeth, plump lips, bright eyes and the absence of sores and legions are universally attractive (Ford & Beach, 1951). These signs of beauty are cross-cultural, with high consensus found about who is and who is not good looking across Asian, Hispanic, Black, and White women, with raters from different cultures (r = .91) (Cunningham, Roberts, Barbee, Druen, & Wu, 1995).

There are some cultural differences in body type of women: the preference for thin or plump partners. In cultures where food is scarce, plumper builds are preferred as compared to cultures where food is plentiful, and the preference is for thinner bodies. For example, in rural South Africa, men showed a preference for a significantly higher BMI than Western observers (Tovée, Swami, Furnham, & Mangalparsad, 2006). Body fat could be a sign of wealth and resources, as only high-status individuals could put on weight- an advantage when food is scarce (Boothroyd et al., 2016). Additionally, in rural Nicaragua, communities with higher nutritional status preferred thinner female bodies than those with lower nutritional status (Jucker et al., 2017). In the UK, one study found peak BMI to be 20.85 (Swami & Tovée, 2005), while in rural Nicaraguan villages, the most attractive BMI was 29.6 (Thornborrow, Jucker, Boothroyd, & Tovée, 2018), while rural Nicaraguan villages, the peak BMI was 29.6 (Thornborrow et al., 2018).

A woman's waist-to-hip (WHR) (defined as the ratio of the width of the waist and the width of the hip (Tovée & Cornelissen, 2001)) is also a key trait to signal health and fertility. Women with higher ratios (e.g. 1.0) have more difficulty becoming pregnant and get pregnant at a later age than women with low ratios (Buss, 2004; Singh, 1995; Singh, 2002). We find that men prefer a lower ratio (e.g. 0.7), and this preference seems to be cross-cultural, with research finding consistent results in Cameroon (Dixson, Dixson, Morgan, & Anderson, 2007), China (Dixson, Dixson, Li, & Anderson, 2007), as well as the UK (Furnham, Tan, & McManus, 1997) and the US (Dixson, Dixson, Bishop, & Parish, 2010). However, some authors argue that the attractiveness of a small WHR is actually a preference for lower BMI, as total body fat has a direct effect on WHR (e.g., Cornelissen, Toveé, & Bateson, 2009).

Short-term Preferences

As well as gender differences in mate preferences, there are different preferences between short and long-term partners. It appears that the threshold for entering a short-term relationship (STR) is different from a long-term (LTR), and has clear gender differences. Specifically, men are more ready to enter an STR: one example in the

literature found that when approached by an opposite-sex stranger who makes sexual advances, 75% of the men approached said yes to sex with the stranger, while 100% of the women said no (Clark & Hatfield, 1989).

To explain the discrepancies between the genders, some authors postulate that societal norms influence men to be more sexually active, while women are influenced to be sexually passive: men are sexually autonomous and women are sexually restrained (Peplau, Rubin, & Hill, 1977). This also relates to the cultural double standard of sexual habits. Men who have multiple sexual partners are “studs”, while women with multiple sexual partners are “whores” (Crawford & Popp, 2003). Another reason could be the aspect of parental investment. As discussed above, women bear the costs of reproduction, whereas men could theoretically reproduce with as many women as he could mate with. With such an unequal cost burden, women are pickier in selecting sexual partners.

Firstly, what are the benefits of a STR for a man? Due to the minimal investment men make to pregnancy, the more casual partners he copulates with, the more potential genetic offspring he can create. A woman, on the other hand, could have many sexual partners, but in a year, would only be able to take one pregnancy to term. However, along with the benefits of casual sex, come costs. Sexually transmitted infections (STI) have been a risk as long as records show, and the risk of contracting an STI increases with each new sexual partner. Additional problems include: risking the reputation of a ‘ladies’ man’, which could make finding a long-term partner more difficult, lowering survival of any offspring due to lack of paternal investment, violence at the hands of husbands or family of the woman, and more recently, the possibility of a costly divorce (Buss, 2004).

It, therefore, seems counter-intuitive that women would participate in short-term relationships, given the increased cost of pregnancy, however, every time a heterosexual man has a casual encounter, there is a woman also having a casual encounter. Possible benefits for women include resource acquisition: through short-term encounters, women

could gain access to foods or services, and by obscuring the father of her child, could manipulate resources from several men at once (Hrdy, 1981). Similarly, multiple partners could increase the security and safety of the woman and infant, as men typically provide defence against predators and other men (Smith, 1984). Secondly, there is potential for the casual partner to provide better genes than their long-term partner, or their partner is infertile, provide sperm to aid conception. These genes could increase her offspring's ability to thrive and survive. Mate switching is similar in theory: because men often divorce cheating spouses, having an affair can facilitate the breakup, if the husband is abusive, or no longer providing for the family, she can "switch" mates to a better prospect (Fisher, 1992). As with men, women also suffer from the costs of a STR: reputation gained as being promiscuous leading to loss of interest from potential LTR, STIs, and bearing offspring without the resources and protection of a long-term partner.

Parental Preferences

The aforementioned preferences discussed assumes that individuals have free choice in their partners, however ethnographic evidence suggests this is far from the case, especially in women's mate choice (Apostolou, 2007). Historically, marriages took place to strengthen families, rather than for love, and as such benefitting the family was more important than benefitting the individuals (Pimentel, 2000). Marriage was a way of raising capital, creating alliances, and consolidating wealth, and in fact, marriage was as much about the in-laws as it was the partner (Coontz, 2004).

Parents have differing levels of input into their offspring's relationships dependent on culture and involvement. In a review of marriage systems in hunter-gatherer societies, parentally arranged marriages were the norm, with 68% of the societies undertaking this form, and 96% of societies having some parental control (Apostolou, 2007). Even in more individualistic Western societies where marrying for love is predominate, parents can still influence or control their offspring's partner choice (Buunk, Park, & Dubbs, 2008). On one end of the spectrum of parental involvement, by the end of the 20th century, half of the marriages in Indian immigrants in the USA were arranged, and a quarter of South

Asians in the USA expected their parents to arrange their marriage (Menon, 1989; Talbani & Hasanali, 2000). At the other, you have parents controlling their offspring's social circle, to ensure they meet the "right type" of person.

As women are generally the choosier sex and often sought after by men, parents of daughters hold an important commodity they can manipulate to their own advantage (Apostolou, 2007). Parents can benefit from a good match in several ways. If the partner provides resources and parental care, the burden on the grandparents will be less. These resources can then be used to increase the likelihood of the survival of offspring, therefore further spreading the parent's genetics. The conflict arises, however, from the battle between resources and fitness benefits. While the parents may want a partner of resources for their daughter, their daughter may want someone who can signal they have good quality fitness to ensure the heredity fitness of their offspring. Parents, however, receive far fewer benefits from having their child pick a partner with high genetic quality. Parents share 50% of their genes with their children, but only 25% with their grandchildren. Therefore, for every unit of physical attractiveness the parent is willing to give up to trade for resources, they lose 0.25 units of genetic quality. However, to the offspring, they lose 0.50 units of genetic quality. This imbalance is responsible for the conflict (Apostolou, 2007, 2011, 2014, 2015).

Apostolou (2007) analysed data from 190 hunter-gatherer societies, and found that overwhelmingly, the parents of a bride want a son-in-law who is hardworking, a good hunter, and comes from a good family, whereas the parents of the groom want a daughter-in-law who is hardworking and comes from a good family. These results were expanded on in a UK sample in 2011, showing that education, intelligence, ambition, industriousness and having good financial prospects were valued significantly more in a son-in-law than a daughter-in-law, or indeed as a partner. The ideal daughter-in-law is a good cook and housekeeper, is good looking, and chaste. However, good looks are more important in a partner than in an in-law (Apostolou, 2011). Buunk et al., (2008) asked over 700 students to identify what they class as unacceptable traits in a partner, and

what their parents would class as unacceptable in an in-law. The results found that traits that lacked signs of heritable fitness (being unattractive, smelling bad) were more unacceptable in a partner than an in-law, while lack of investment (poor income) was more unacceptable to parents.

There is also conflict in the gender of the parent and the offspring. Dubbs & Buunk (2010) asked students to rate traits as to how unacceptable they would be to their mother and their father in a potential partner. Fathers were perceived to disapprove of sons-in-law with low education and income, who were physically unfit, and who were a different ethnic background and lower social class. The perception of what mothers would disapprove of included being unattractive, fat, unhygienic, being unkind or unfriendly, lacking creativity, lacks respect/obedience, has had many sexual partners, and does not like, or cannot have, children. In this study, mothers were by far perceived as the choosiest over daughter's partners. This may be due to the grandmother hypothesis: the idea that menopause evolved as it is far more beneficial fitness wise for a woman to care for grandchildren than it is for her to continually reproduce (Alvarez, 2000). Grandmothers tend to be more involved in the care of grandchildren, which is reflected in their undesirable traits in the above study, while grandfathers appear to be more concerned with resources and social standing. Dubbs & Buunk (2010) have replicated these findings across many cultures: the USA, the Netherlands, Kurdistan, Argentina, Uruguay, and Japan (Buunk et al., 2008; Buunk & Solano, 2010; Dubbs, Buunk, & Taniguchi, 2013; Park, Dubbs, & Buunk, 2009).

Parental Influence

As well as having preferences for their offspring's mate, parents can also influence their offspring's mating decisions in another way: sexual imprinting. Sexual imprinting occurs when an individual learns a sexual preference by observing the phenotype of another individual, usually learned before sexual maturity, and not learned through courting experience (Immelmann, 1975; Invernizzi & Gilman, 2015).

Negative imprinting and imprinting-like mechanisms

Negative imprinting is a sexual aversion to those who raised, or were raised with, an individual when they were young, also known as the Westermarck effect (Westermarck, 1903). This appears to be a clear evolutionary mechanism to avoid inbreeding consequences, which can be very severe for the offspring of closely related parents. Some animals avoid those raised in their peer or family groups when mating begins: prairie dogs (*Cynonys ludvicianus)* avoid mating with close kin (Hoogland, 1992), female lions (*Panthera leo*) postpone sexual maturation if their father or male siblings are present during their maturation (Hanby & Bygott, 1987), and baboons (*Simia hamadryas*) leave their native group to mate (Livingstone, 1980). In humans, research has found that the ramifications of inbreeding for the child is higher prenatal, neonatal, and infant mortality, as well as diminished mental abilities and congenital malformations (Seemanova, 1971), and very low IQ has also been reported in children of incest (Adams & Neel, 1967). The risk of inheriting deleterious recessive genes is four times greater for children of incest than for children of first cousins (Seemanova, 1971), and so it makes evolutionary sense to have a mechanism in place to avoid these consequences.

Indirect Kinship Cues

It is believed that high estimated kinship cues trigger this sexual aversion (Lieberman, Tooby, & Cosmides, 2003). Such indirect cues include the duration of co-residence and maternal-infant perinatal association (MPA). Duration of co-residence is the proximity to others during an individual's development and is a reliable cue of relatedness. Typically, this would include siblings and parents, but can also extend to non-related individuals. Mutual sexual aversion, higher divorce rates, and lower numbers of children are reported in Lebanese patrilateral parallel cousin marriages, where a boy marries his father's brother's daughter (McCabe, 1983), in matrilateral cross-cousins of Sumatra, where a boy marries his mother's brother's daughter (Fessler, 2007), and in the Taiwanese tradition of "little daughter-in-law", wherein daughters are betrothed at a young age, and often raised with their future husband (Wolf, 1970).

Similarly, in an Israeli Kibbutz investigated by Shepher (1971), children were raised together as peer groups. Out of 2769 marriages, only 14 were between peers, and none of the 14 that married had been raised together before the age of six. Further research reported that adults raised together as children reported a lack of sexual desire for their peer group (Shepher, 1983), suggesting the co-residence duration had triggered this response. However, according to later research, sexual expression was censored in the Kibbutz until the late 1970s, which could account for the lack of sexual desire for peer group members (Shor & Simchai, 2012). Additionally, when members were re-interviewed, no incidences of sexual aversion to peer group members were reported (Shor & Simchai, 2009), and in fact, in-group relationships were viewed more favourably than between siblings, suggesting that co-residence may not always provoke sexual aversion in the same way between related and non-related individuals (Lieberman & Lobel, 2012).

Maternal-infant perinatal association (MPA) describes the act of watching your mother care for (e.g. nurse) your new-born siblings (Lieberman, Tooby, & Cosmides, 2007), and this acts as a kinship cue, as it is likely that infant is your sibling. Kin detection through MPA is only available to older siblings, as younger siblings will not witness their older siblings being nursed. It is therefore thought that younger siblings use the duration of co-residence, while older siblings use MPA exclusively (De Smet, Van Speybroeck, & Verplaetse, 2014; Lieberman, Tooby, & Cosmides, 2007b; Sznycer, De Smet, Billingsley, & Lieberman, 2016)

Direct Kinship Cues

The major histocompatibility complex (MHC) may be a direct cue to kinship, as opposed to the indirect cues mentioned previously. The MHC is a genetic marker that examines forms of genetic variation (Sommer, Courtiol, & Mazzoni, 2013). MHC variants influence important biological functions, like immune recognition, susceptibility to infection/ auto-immune disease, mating preferences, and crucially, family recognition through recognising genes or chromosomes as either homozygous or heterozygous, a key part

of the mammalian immune system (Kulshrestha, 2017). Heterozygotes are expected to have higher fitness than homozygotes: genotype AB is higher in fitness than AA or BB, as AB results in higher MHC diversity, and therefore enhanced survival due to increased resistance to parasites and pathogens (Gasparini, Congiu, & Pilastro, 2015).

MHC genotypes also contribute to each individual's specific odour, and familiarisation with that scent can be a cause of aversion (Schneider & Hendrix, 2000). This odour-based aversion is seen in animals, and possibly humans. Firstly, female mice prefer to mate with a mouse carrying dissimilar MHC genes, and this appears to be detected by odour (Penn & Potts, 1998). Male mice prefer also prefer females with different MHC (Yamazaki, Boyse, Thaler, & Mathieson, 1976). Stallions (*Equus caballus*) exposed to MHC dissimilar mares had enhanced plasma testosterone and elevated sperm numbers compared to when exposed to MHC similar mares (Jeannerat et al., 2018). In humans, mothers can recognise their baby merely by odour, babies can recognise their mothers similarly (Stoddart, 1991), and even grandmothers and aunts can identify which shirts were worn by their new-born relative (Porter, Balogh, Cernoch, & Franchi, 1986). The familiarisation of the scents of close relatives could also lead to an aversion in humans. Studies investigating MHC and/or odour preferences use the "t-shirt task": men and women sleep in the same t-shirt for several days and then participants select the smell they prefer or dislike. In one particular study, women preferred the t-shirts worn by men, which had an odour more dissimilar to their own odour. In addition, the odour of the MHC dissimilar men reminded women of their current/former partner (Wedekind & Penn, 2000).

Positive Imprinting and Imprinting-like Mechanisms

Conversely, positive imprinting has been studied extensively in animals, particularly birds, wherein sexual imprinting seems to be the rule rather than the exception (ten Cate & Vos, 1999). In birds, imprinting most commonly occurs on paternal traits, however, there is evidence towards maternal imprinting in Darwin's finches (*Geospiza fortis)*, Zebra finches (*Taeniopygia guttataI),* and Mallard ducks (*Anas piatyrhynchos*) (Grant &

Grant, 1997; Klint, 1978; Vos, 1995). Note that the individual used for imprinting does not have to be a biological parent: experiments successfully use cross-fostering, and in species where extra-mate pairing is common, the father may not be the one raising the offspring (see the Superb fairy-wrens (*Malurus cyaneus*), when extra-pair paternity rates can be as high as 72% (Mulder & Magrath, 1994)). The phenotype imprinted upon can be beneficial or maladaptive (Invernizzi & Gilman, 2015), and may occur regardless of whether the traits are beneficial; thus it is theorised that a daughter with a father demonstrating traits of low genetic quality will imprint upon those markers, in spite of cost (Rantala & Marcinkowska, 2011). There appears to be a two-stage process to imprinting: acquisition, where the phenotype is imprinted, and consolidation of the preference at sexual maturity (Bischof & Oetting, 1996).

Imprinting research in birds tends to centre about cross-fostering experiments: where birds of a particular species are raised by another species. Preference testing then occurs at varying time-points, in order to see if the cross-fostered bird prefers its own species or that of the foster parents. For example, male zebra finches were raised by Bengalese finches (*Lanchera striata*) and isolated as adolescents. Evidence to show that their preferences for their fostered parents were consolidated was demonstrated, as even when exposed to Bengalese finches for very short periods of time (2 x 20 minutes or 3 x 30 minutes), the finch preferred the Bengalese to the Zebra (Immelmann, 1975; Kruijt & Meeuwissen, 1991). Similarly, Japanese quail (*Coturnix japonica*) prefer to mate with an individual that is different, but not too different, to the birds they were reared with (Bateson, 1978), and would prefer to mate with first cousins to siblings (either familiar or reared apart), or unrelated birds. Those birds that did mate with their first cousins lay fertile eggs before the birds that mated with their siblings or unrelated birds, signifying imprinting upon familiar traits may have reproductive benefits (Bateson, 1988). However, it seems that in some species at least, the imprinting can be reversed through courtship experience. When Zebra finches were raised by Bengalese finches for their first 40 days, they showed a preference for Bengalese finches (i.e., the foster parents). Despite this

preference, when given three months of breeding experience with a Zebra finch, their preference then turned to Zebra finch (Kruijt & Meeuwissen, 1991).

In humans, there may be some evidence of imprinting upon parents. Both biological and adopted daughters had partners who looked like their fathers, as judged by naïve participants, who correctly matched son-in-laws to fathers as most similar to each other (Bereczkei, Gyuris, Koves, & Bernath, 2002; Bereczkei, Gyuris, & Weisfeld, 2004; however cf. Marcinkowska & Rantala, 2012). An early study found that children of mixed-race parents tend to marry partners of the ethnicity as their opposite-sex parent (Jedlicka, 1980), with a more recent study finding that the sex of the parent was inconsequential, and that individuals partnered with someone who looked like either parent (Heffernan, Chong, & Fraley, 2018). Similarly, daughters of older fathers marry older men (Zei, Astolfi, & Jayakar, 1981). This has been replicated in more recent times by Heffernan & Fraley (2013) with actual partners, and also in that daughters prefer computer generated faces similar to their father's age when they were young (Perrett et al., 2002). Parents' height has been found to correlate with partner height (Seki, Ihara, & Aoki, 2012), and male partner's body hairiness correlates with the daughter's father's hairiness (Rantala, Pölkki, & Rantala, 2010), and also with daughter's preference for hairiness (Valentová, Varella, Bártová, Štěrbová, & Dixson, 2017). Further, a sample of Czech and Brazilian men preferred a waist-to-hip ratio similar to their mother, and Czech men also preferred breast size similar to their mothers (Valentova, Bártová, Štěrbová, & Varella, 2017).

Evolutionary research has placed a particular focus on the imprinting of parental hair and eye colour. Eye colour is easily measurable, stable across time, and placed centrally in the face, salient in interactions, and unaffected by age, gender, or health (Bressan & Damian, 2018). Hair colour is more complicated, as hair dye and natural greying or balding can change hair over the lifespan. There seems to be support for imprinting in eye colour: teenage girls' boyfriends' eyes matched their fathers' eyes at a higher rate than matching with their mothers (Wilson & Barrett, 1987). Parents' hair and eye colours correlated positively with heterosexual partner characteristics for both men and women,

but the opposite-sex parent had greater importance in predicting partner characteristics. This was expanded further to include non-heterosexual participants and found that rather than strictly opposite-sex parents, the parent the same-sex as the individual's partner was the greatest influence on eye colour matching in their partner (DeBruine, Jones, & Little, 2017). Having a light-eyed father increased participants' preferences for a light-eyed man in manipulated images, and the colour of their father's eyes was a significant predictor of their actual partner's eye colour (Bressan & Damian, 2018).

Interestingly, in Bressan and Damian's work, they found that the imprinting was modulated by the quality of the relationship between daughter and father. Research has also found that women who retrospectively reported greater support from their mother or father after menarche predicted stronger preferences for partners whose eye colour matched that of the parent, while those reporting greater support pre-menarche predicted dissimilarity to that parent. Some support for hair colour matching was also found, particularly in terms of maternal hair colour and preferred partner hair colour (Saxton, 2016). The mediating effect of parental relationship can be seen as early as nine years old, where children with good relationships with their parents prefer parentally similar faces (Vukovic, Boothroyd, Meins, & Burt, 2015). This mediation is not clear, however, as in one study, it was found that men chose women similar to their mothers when they experienced rejection from their mother during childhood (Gyuris, Járai, & Bereczkei, 2010).

However, imprinting in humans is a controversial topic. Firstly, imprinting can be defined as an association of specific behaviour with a specific stimulus, without any need for strengthening or conditioning (Lorenz, 1982). The fact that the quality of relationship seems to mediate the imprinting effect has led to authors such as Little, Penton-Voak, Burt, and Perrett (2003) to deem it an "imprinting-like" effect. Another issue is that we do not know when the time-sensitive period that imprinting takes place is in humans. In animals, it seems to be in the very early weeks from birth (e.g., Kruijt & Meeuwissen, 1991) and occurs in both male and females. Few studies have investigated how early

this preference is formed and actioned. Gyuris & Kocsor (2018) manipulated images to resemble the parents of children aged between three and fourteen years old and tested preferences using a forced-choice paradigm. Parental preference was present in 11-14-year-olds who had good relationships with their mother, particularly with boys. This effect was also found for boys aged 3-6 and 7-10 years old, however not with girls. This again leads to the concept of an imprinting-like effect, rather than an exact replica of the imprinting found in animals. The effect could instead be a learned mechanism, where children who experience strong relationships with their parents then use that person's phenotype to create a mate template.

Optimal outbreeding

Optimum outbreeding is the balance of mating with a partner who is genetically dissimilar enough to avoid inbreeding consequences, but similar enough to have the necessary adaptations to survive the environment (Bateson, 1978, 1983; Bateson, 1980). Evidence for optimal outbreeding is predominately based in the animal literature. Bateson (1980) found that Japanese quails (*Cotunix japonica*) were attracted to the general characteristics of their siblings, but avoided mating with them, suggesting that optimal outbreeding was a factor in their mate choice, in that mating preferences of the Japanese quail are influenced by their relationships in infancy, allowing them to achieve the most favourable balance between inbreeding, and outbreeding. Similarly, the Canada Goose (*Branta canadensis)* seems to engage in outbreeding behaviours, and will only mate with a member of their brood if separated before hatching occurs (Aberle et al., 1963), and likewise for rhesus macaques (*Macaca mulatta)* (Widdig et al., 2017).

In humans, we see evidence of optimal outbreeding in the Icelandic population data. Data was collected from all known Icelandic couples between 1800 and 1965, with results showing that the most reproductively successfully couples were related at the level of third or fourth cousins (Helgason, Pálsson, Guðbjartsson, Kristjánsson, & Stefánsson, 2008). This level of relatedness appears to be optimum: avoiding the consequences of first cousin reproductive (e.g. infant death rate of 1.1%, Bittles & Black,

2010), but being related enough to reap the social and economic benefits. This is particularly evident in societies that suffer from malaria, when inbreeding to a degree can increase the frequency of alleles protective against malaria, providing a benefit outweighing inbreeding costs (Denic, Nagelkerke, & Agarwal, 2011).

Self-similarity and homogamy

Conversely, this imprinting effect may also be a self-similar preference or assortative mating. Positive assortative mating occurs when individuals prefer those similar to themselves (homogamy). This can be personality, physical appearance, or even genetic similarities.

At the personality level, one of the strongest effects for self-similarity is religiosity with a correlation of r = .72 - .74 (Sherlock et al., 2017; Zietsch, Verweij, Heath, & Martin, 2011), followed by level of education, with a correlation of r = .45 - .48 between couples (Jonason & Antoon, 2019; Sherlock et al., 2017; Zietsch et al., 2011; Zou et al., 2015), and by intelligence (r = .40, Mascie-Taylor & Vandenberg, 1988). Couples' social attitudes also seem to correlate strongly, with estimates ranging from r = .61 - .67 (Sherlock et al., 2017; Zietsch et al., 2011).

Couples seem to have similar senses of humour, with one study finding that responses from one partner on a humour styles questionnaire significantly and positively predicted the responses by their partner (Hahn & Campbell, 2016). Similarly, couples seem to have similar levels of conscientiousness and extraversion (r = .33 and .25 respectively, (Little, Burt, & Perrett, 2006). Novelty seeking seems more controversial, with correlations between couples ranging from r = .09 - .33 (Bon et al., 2013; Sherlock et al., 2017), and some moderate effects have been found regarding dark triad traits in couples (Kardum, Hudek-Knezevic, Schmitt, & Covic, 2017).

Physically, couples tend to be the same race (McClintock, 2010; Potârcə & Mills, 2015), a term coined to be racial homophily. In the U.S.A., data from the 2000 census showed that among married black individuals, 94% were married to other black people (Fisman,

Iyengar, Kamenica, & Simonson, 2008). In a speed-dating study, Fisman et al., (2008) reported women of all races showed strong same-race preferences, while men did not, and older individuals had a weaker preference than younger participants did.

The attractiveness of a couple also seems to be similar: Feingold (1988) conducted a meta-analysis of matching for attractiveness in couples, using 27 samples. Inter-partner correlations were consistent across all samples: r = .39, CI [.34- .44], raised to r = .49, CI [.42, .55] after correction for attenuation. More recently, correlations between participants' attractiveness and speed dating picks were r = .60 (Lee, Loewenstein, Ariely, Hong, & Young, 2008), and r = .43 between established couples rating their perceived attractiveness (Little et al., 2006), but see Shaw Taylor, Fiore, Mendelsohn, and Cheshire (2011) who found no evidence for such an effect. In fact, the authors found that the initiator in an online dating paradigm was significantly less attractive than their desired partner.

There is also a body of evidence indicating a modest effect of assortative mating for height. A meta-analysis conducted on 154 within-pair correlations for height within established couples found that 148 were positively correlated, and only 6 were negative (Stulp, Simons, Grasman, & Pollet, 2017). For the Western samples, a correlation of r -.25, 95% CI [.21-.26], p <.0001 was found, and non-Western samples were similar: r = .21, 95% CI [.17-.25], p < .0001.

In genetic and phenotypic terms, recent advancements in technology have allowed us to question whether assortative mating happens on a genetic level, as well as a physical and personality level. Firstly, we see strong evidence for assortative mating within psychiatric disorders. Spousal correlations of r = .40 for attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and schizophrenia, with substance abuse spousal correlations at a similar level (r = .36- .39) (Nordsletten et al., 2016). More generally, a recent study analysed 24,662 spousal pairs, and found evidence to support positive correlations in genetic value among partners for a range of different phenotypes (Robinson et al., 2017). In samples of Latino couples, couples were significantly more

likely to have similar genotypes in facial development genes than expected based on chance (Zou et al., 2015). In contrast, a twin-study found that only 7% of the variation in the tendency to mate assortatively across 14 traits was genetic (Sherlock et al., 2017). Other studies found that while spouses are more genetically similar than two individuals chosen at random, the similarity is roughly only one-third of the magnitude of educational similarity mentioned above (Domingue, Fletcher, Conley, & Boardman, 2014; Guo, Wang, Liu, & Randall, 2014).

Aims of this thesis

Human mate choice is a complex, multi-faceted area of research that requires further work. This thesis aims to add to the literature in several areas of mate choice, to address outstanding questions in empirically sound and novel methods.

Firstly, there are many conflicting theories and research surrounding men's masculinity, specifically whether men's facial appearance can provide cues to women regarding their genetic health and/or behaviour. The immunocompetence handicap hypothesis was introduced as a way to explain males signals of health, as testosterone simultaneously enhances sexual ornaments while suppressing the immune system (Folstad & Karter, 1992). However, this may not be the case in humans, with many mixed results regarding men's facial masculinity and health, and mostly focusing on perceived masculinity rather than objective, structural masculinity (e.g., Boothroyd et al., 2009, 2013). In addition, women are theorised to make a trade-off between good genes and a good co-parent (Andersson, 1994; Trivers, 1972). Men with good genes should maximise their reproductive fitness by focussing effort into acquiring multiple sexual partners, while poorer quality men should maximise their fitness by investing in parenting (Penton-Voak et al., 2003). We aim to investigate this potential relationship further, by using self, daughter, and mother reports of how good a father each man is, and analysing these reports in conjunction with their facial masculinity, both structurally and perceived, and their fWHR.

Next, we will take a further look into the Westermarck effect, which theorises that humans develop a sexual aversion to individuals who are closely related (Marcinkowska, Moore, & Rantala, 2013; Westermarck, 1903). As inbreeding costs are so high, particularly for women, cues of kinship can help an individual avoid inbreeding. Previous work has showed that self-similar faces (used a proxy for relatedness) are less attractive than dissimilar faces (DeBruine, 2005; Zhuang, Zhang, Xu, & Hu, 2014), particularly to single individuals who are actively looking for a partner (Lindova et al., 2016). However, other work has found preferences for self-similar faces, particularly in men (Bovet, Barthes, Durand, Raymond, & Alvergne, 2012; Kocsor, Rezneki, Juhász, & Bereczkei, 2011; Sulutvedt & Laeng, 2014). Much research investigating the Westermarck effect in humans use self-report measures, which may not be as reliable as objective measures. We wish to add to this literature by including a physiological measure of disgust, using electromyography on the specific disgust muscle.

Research has shown many couples resemble each other in different ways, for example, personality, appearance, or genetic similarities. This is known as assortative mating, when individuals mate with someone more similar than themselves than by chance. Evidence supports assortative mating most strongly for religiosity and education, and also moderately for own-race marriages, attractiveness (Feingold, 1988; Hahn & Campbell, 2016; Jonason & Antoon, 2019; McClintock, 2010; Sherlock et al., 2017; Zietsch et al., 2011; Zou et al., 2015). However, despite these similarities, little is known about couples' body language. We will use state of the art motion capture technology in order to see if assortative behaviour also extends to body language.

Finally, we will look into imprinting-like mechanisms in humans. In animals, particularly birds, sexual imprinting has been studied extensively; however, in humans it is less clear. Research has found that women's partners look like their fathers or brothers, and that men's partners look like their mothers (Bereczkei et al., 2002, 2004; Saxton, Steel, Rowley, Newman, & Baguley, 2017). Daughters of older fathers marry older men and also prefer older computer generated men, and parents' height and hairiness correlate

to partners' (Heffernan & Fraley, 2013; Perrett et al., 2002; Rantala et al., 2010; Seki et al., 2012; Valentová, Bártová, et al., 2017; Zei et al., 1981). Evolutionary psychology focuses on eye colour of partners frequently, and finds evidence for parent-matching eye colour in partners (e.g. Bressan & Damian, 2018; Debruine et al., 2017; Wilson & Barrett, 1987). However, the majority of studies use current partner's eye colour, or ideal partner, as a measure of eye colour imprinting. We will examine this imprinting-like mechanism using participants' entire dating history, in order to look for life-long parental eye colour matching preferences, as well as looking for self-similarity preferences.

As a whole, the literature in this area traditionally uses survey methods, however in order to add measures that are more objective, this thesis will use survey methods in combination with novel methods: facial morphology and measurements, facial electromyography, and motion capture technology.

Thus, the research questions for this thesis are as follows:

1: Is a 'good' father identifiable through cues in his face?

2: Do self-report and physiological measures of disgust show support for avoiding sexual contact with kin?

3: Are couples identifiable through self-similar body language, adding further support to the theory of assortative mating?

4: Finally, do individuals have a "type" in terms of preferences for eye colour, and is that type influenced by their parents via an imprinting-like mechanism?

Chapter 2: What makes a bad dad? Investigating facial structure and fathering abilities.

Introduction

Much research suggests that facial appearance can indicate mate value, as well as aspects of likely behaviour. Some of this research focuses on what male masculinity may indicate to prospective mates (DeBruine et al., 2006; Little, Jones, & DeBruine, 2011; Rhodes, 2006). As mentioned in Chapter One, this idea stems from the immunocompetence hypothesis (Folstad & Karter, 1992), which holds that testosterone could enhance male secondary sexual characteristics, while simultaneously suppressing the immune system, and therefore leaving vulnerabilities for infection and disease (Rantala et al., 2012). From a reproductive point of view, only men of high genetic quality can "afford" the stress on their immune system in order to display these attractive, masculine characteristics (Roney, Hanson, Durante, & Maestripieri, 2006). While high-testosterone men will pass their good genes to their offspring, they may not make great parents; higher testosterone has been linked to increased levels of infidelity, violence, and divorce (Booth & Dabbs, 1993), none of which makes a supportive and nurturing father. The immunocompetence theory as it relates to men's facial attractiveness has been criticised, not least for the tentative link between masculinity and heritable health (see e.g. Scott et al., 2014; Scott, Pound, Stephen, Clark, & Penton-Voak, 2010; Scott, Clark, Boothroyd, & Penton-Voak, 2013).

In contrast to the immunocompetence theory of masculinity, other work suggests that perceived masculinity is negatively associated with perceived paternal tendencies. For example, unacquainted raters perceived men with highly masculine faces as lower quality parents (Perrett, Lee, & Penton-Voak, 1998), and participants selected a less over a more masculine morph of a male face as being better at taking care of children and sharing resources with his family (Kruger, 2006). Male faces, when digitally altered to appear less masculine, are also perceived as being more trustworthy, reliable, and

less selfish than faces with digitally increased masculinity (Johnston, Hagel, Franklin, Fink, & Grammer, 2001).

The view that masculine men may be worse fathers is pervasive amongst the literature and has been incorporated into many different theories of mating. When choosing a romantic partner, women are thought to make a trade-off between seeking partners who can contribute the direct benefits of high genetic quality, and partners who can contribute the indirect benefits of investment in parenting (Andersson, 1994; Trivers, 1972). Men with higher genetic quality can maximise their fitness by channelling effort into mating with multiple women instead of parenting; men with poor genes should maximise their fitness by investing in parenting (Bereczkei, Voros, Gal, & Bernath, 1997). These characteristics should theoretically correlate negatively: the higher the gene quality, the lower the investment and vice versa, meaning that female preferences for exaggerated secondary sex characteristics in males evolved from these characteristics being an honest proxy for desirable genetic quality (Penton-Voak et al., 2003).

There is some evidence that these trade-offs also influence mating behaviour within women. Some researchers have reported that women have stronger preferences for male masculinity at peak fertility (Penton-Voak et al., 1999; Johnston et al., 2001; Jones et al., 2008; Little et al., 2007; Little & Jones, 2012; but see Jones et al., 2017 and Wood, Kressel, Joshi, & Louie, 2014). These apparent preference shifts have been interpreted as an adaptation, whereby when women are most likely to become pregnant, the ideal partner would be high in genetic quality, whereas attraction to altruistic and co-operative males increases during less fertile phases. Pill users, whose hormonal profile may be closer to that of pregnancy (Alvergne & Lummaa, 2010), seem to experience either a lack of cyclical shifts or a weaker preference shift (Jones et al., 2017). Similarly, in short-term mating contexts, when genetic quality is again more relevant than parenting ability, women have been found to prefer masculinity more than for long-term mating (Little, Jones, Penton-Voak, Burt, & Perrett, 2002; however see Wood, Kressel, Joshi, & Louie, 2014). Additionally, it has been suggested that this trade-off between masculinity and

investment differs between cultures. For example, in Jamaica, parasite risk is higher, medical care is less common, and paternal investment is lower than in the U.K. Jamaican women preferred a greater degree of masculinity than British women, potentially due to their emphasis on genetic quality over the less common investment strategies based upon the poorer health of the country (Penton-Voak, Jacobson, and Trivers, 2004).

Despite the theoretical emphasis and a plethora of research suggesting masculine men are poorer parents, no research to date has shown direct evidence of this. Men rated as masculine by women judges were less interested in infants when given a forced choice paradigm between a photo of a baby and an adult (Roney, Hanson, Durante, and Maestripieri, 2006). However, the relationship between perceived parenting ability and actual parenting ability judged by both the parents and the offspring has not been tested, leading to questions regarding the validity of the idea that masculine men invest less in parenting.

One shortcoming of previous studies is that they did not assess actual paternal behaviour. Additionally, there are concerns regarding the validity of popular facial masculinity measures as behavioural indicators. Many studies rely on perceived masculinity, as opposed to structural, or physical, masculinity (e.g. Rhodes, Chan, Zebrowitz, & Simmons, 2003; Roney et al., 2006). Pound, Penton-Voak, and Surridge (2009) argued these are not interchangeable and often uncorrelated. Perceived masculinity is subjective, whereas structural masculinity is objective. Scott, Pound, Stephen, Clark, & Penton-Voak (2010) criticised the subjective nature of perceived masculinity ratings, preferring instead a way of objectively measuring masculinity. The authors, therefore, suggest a method to measure masculinity structurally via the location of five facial landmarks. To combat the issues with masculinity judgements, the facial width-to-height ratio (fWHR; Weston, Friday, & Liò, 2007) has been proposed as a more reliable marker of behaviour in males (e.g. Carre & McCormick, 2008; Stirrat & Perrett, 2010, 2012).

fWHR does not seem to be an intersexually selected trait, as male fWHR is negatively associated with women's judgements of attractiveness (Geniole, Denson, Dixson, Carré, & McCormick, 2015). This has led some authors to argue that larger fWHR is intrasexually selected due to observed links to aggression in football players (Welker, Goetz, Galicia, Liphardt, & Carré, 2015) and social aggression in reaction to perceived slights (Haselhuhn, Ormiston, & Wong, 2015). Indeed, larger fWHR predicts aggression, but those with larger fWHR are also perceived as less faithful, and less investing as fathers (Johnston et al., 2001). Conversely, smaller fWHR predicts more reciprocation behaviour and higher levels of trustworthiness in trust games (Stirrat & Perrett, 2010), both of which are useful in a long-term mate and offspring. Moreover, fWHR reflects testosterone effects on the bone structure during adolescence (Verdonck, Gaethofs, Carels, & de Zegher, 1999), and is therefore fairly consistent over time (Re et al., 2013).

Aims

Critically, previous studies assessing links between masculinity and presumed paternal tendencies relied on perceived masculinity, but not using structural masculinity, or fWHR. This is crucial, as masculinity judgements may be influenced by fWHR. It is, therefore, possible that perceptual links between appearance and perceived parenting are not driven by masculinity, but by fWHR. Similarly, perceived parenting may not be associated with actual parenting, and thus we address this issue by investigating whether reported parenting quality is associated with objective facial appearance. We measured masculinity and fWHR of men with adult daughters. We assessed fathers' parenting ability through self-report, daughter report, and mother report. Here, we explore for the first time, the relationships between actual paternal behaviour, structural masculinity, and fWHR.

Methods

Participants

The participants consisted of 100 family triplets (daughter, mother, and father). Daughters were 18- 32 (mean = 20, SD = 3 years old), mothers were aged 37-71 (mean = 51, SD = 5 years old), and fathers were aged 38-74 (mean = 53, SD = 6 years old).

Participants were recruited through opportunity sampling with undergraduate Psychology students at a university in the northeast of England. All participants provided informed consent and had lived as a family unit until the daughters were at least 16 years old. Data collection took place over two different periods based on insufficient sample size on first collection. The sample size was not based on power calculations but reflected the number of participants we were able to recruit in the time available for this project. Ethical approval was obtained from the Northumbria University Department of Psychology Ethics Committee before any recruitment began, and all participants were compensated for their time.

Materials and Procedure

Procedure

Daughters were directed to a pre-screen questionnaire hosted by Qualtrics (www.qualtrics.com) to confirm that they were white British females, and had lived with their biological parents until at least the age of 16 years old. These restrictions were used to reduce possible confounding cultural differences. If they were suitable for the research, they provided age and sexual orientation and completed an adapted version of the Nurturant Fathering Scale (Finley, 1998), and were asked to encourage their mother and father to enrol on the study.

The Nurturant Fathering Scale

The nine-item Nurturant Fathering Scale (NFS) (Finley, 1998) was adapted in order to be suitable for adult daughters, as well as for mother reports and father self-reports. Items and instructions did not vary across the different scales except for the person

descriptions, e.g. "[*Was your father/was your daughter's father/ were you*] *available to spend time with* [*you/your daughter*] *in activities*?" (Versions to be found in Appendices 1-3). All questions were answered using a scale from 1-5, where one is never/poorly and five is always/outstanding. Total scores ranged from 9-45. Research found the NFS to have high internal consistency in a large ethnically diverse sample of adolescents and young adults (Williams & Finley, 1997), with Cronbach's alpha ranging from .88 to .90 (Finley, 1998; Williams & Finley, 1997).

Facial Photographs

Each daughter was invited to submit a standardised photograph of her father. The daughters were supplied with a set of instructions detailing how to take the photographs. This included that glasses should be removed, hair held out of the face, and photographs to be taken straight on from a distance of 1m. In addition, fathers were requested to maintain a neutral facial expression.

Measurement Techniques

fWHR was measured from each photograph following the procedure in Lefevre, Lewis, Perrett, & Penke (2013), measuring the distance between the left and right boundary of the face (zygion to zygion) (width) divided by the distance between the middle upper lip (prosthion) and the highest point of the eye-lid (nasion) (height), see Figure 1. Higher ratios correspond to higher ratios, i.e. broader faces.

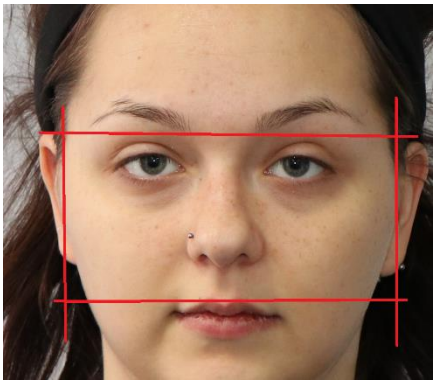

Figure 1: fWHR measurements, zygion to zygion, prosthion to nasion

To calculate sexual dimorphism we followed the analysis by Zhang et al. (2019). Firstly, all faces were delineated in Webmorph (DeBruine, 2017), with 132 points, and then the facial landmarks were analysed in R using two methods: a discriminant analysis and a

vector analysis method (Zhang et al., 2019, The code used is freely available here: https://osf.io/98qf4/). Both methods use shape information derived from principal component analyses of the facial landmarks to measure the probability of a face being classified as male (discriminant analysis) or to locate the face on a female-male continuum (vector analysis). Higher scores for both measures indicate more masculine face shapes. See Table 1 and Figure 2 for descriptive statistics.

Table 1: Descriptive statistics for each facial measure

Measure	Mean (SD)	Range
fWHR	0.80 (0.25)	0.57- 2.20
Discriminant Masculinity	- 0.56 (0.94)	-2.62 – 2.20
Vector Masculinity	0.50 (0.41)	-0.51 – 1.77
Perceived Masculinity	4.48 (0.58)	1 - 7

A sub-sample of fathers gave their permission for their photograph to be rated for perceived masculinity (n = 17). A separate set of 20 women (age range 19-43, M = 26.71 SD = 6.41) rated each father for how masculine they were on a scale of 1 (not masculine) to 7 (extremely masculine). Descriptives can be found in Table 1 and Figure 2.

Vector and discriminant masculinity correlated with each other: r_s = 0.512, p < .001, 95% CI [0.324, 0.672] and vector masculinity correlated with fWHR: r_s = 0.217, p = 0.042, 95% CI [-0.008, 0.414] but discriminant masculinity did not: r_s = 0.073, p = 0.500, 95% CI [0.122, 0.267].

Figure 2: Violin plot showing spread of masculinity measures

Perceived masculinity did not correlate with either objective masculinity measure or with fWHR (fWHR: r_s = 0.235, p = 0.363, 95% CI [-0.319, 0.701]; vector masculinity, r_s = 0.031, p = 0.907, 95% CI [-0.425, 0.494]; discriminant analysis, r_s = 0.354, p = 0.163, 95% CI [-0.169, 0.737])

Results

Firstly, we assessed whether there was agreement between parents and daughters on the Nurturant Fathering Scale. We found Cronbach's alpha for the daughters' responses to be .91, for the fathers' responses .79, and the mothers' .87

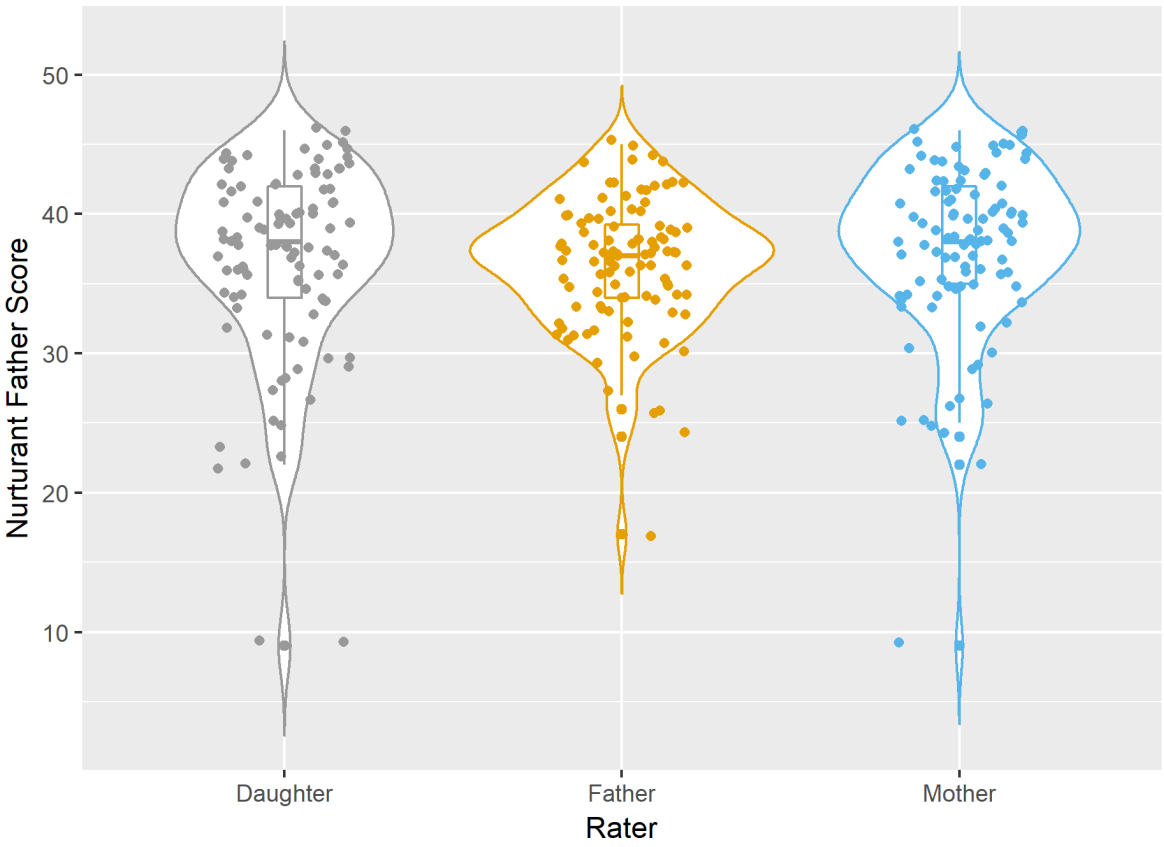

Figure 3: Spread of NFS Scores by triplet

The fathers', mothers', and daughters' scores were highly correlated with each other (See Figure 3 and Table 2) and so an aggregate score was calculated for each father by averaging the questionnaire answers from the parent-daughter triplets (M = 28.57, SD = 4.71, range = 7.89 - 35.00, see Figure 3).

Table 2: Spearman's correlations between mothers', fathers' and daughters' ratings of the father on the Nurturant Father Scale

	Mother's report M= 37.51 (6.24)	Daughter's report M=36.69 (7.02)
Father's self-report M= 36.39 (4.75)	r_s= .568, p <.001, 95% CI [0.396, 0.703]	r_s=.607, p <.001, 95% CI [0.451, 0.735]
Mother's report		r_s= .601, p <.001, 95% CI [0.438, 0.723]

The data showed evidence that higher fathering scores corresponded to greater structural masculinity as measured by discriminant masculinity (r_s (92) = 0.231, p = 0.027, 95% CI [0.050, 0.394], See

Figure 4), but not to masculinity vector: r_s (92) = .142, p = 0.176, 95% CI [-0.053, 0.343], nor to perceived masculinity: r_s (17)= - 0.182, p = 0.486, 95% CI [-0.670, 0.342].

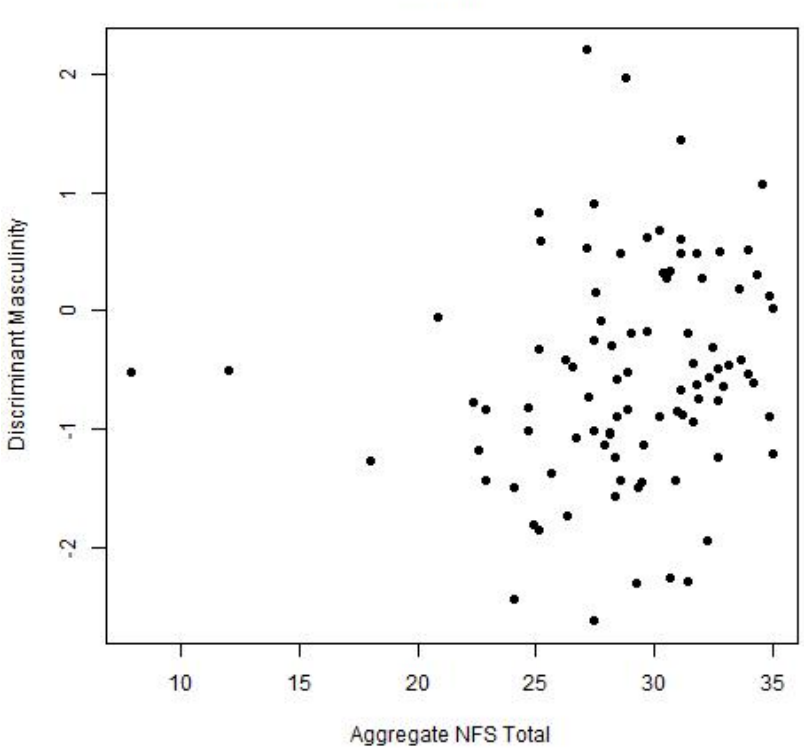

Figure 4: Scatter relationship between Discriminant masculinity and NFS

We find no relationship between fWHR and fathering scores: r_s (88) = .029, p = .791, 95% CI [-0.029, 0.225].

All data and R analysis can be found at the following link:

https://osf.io/t39sy/?view_only=eb04792ecda04202a25d508a92192272.

Discussion

The literature typically suggests that women are faced with a trade-off regarding reproductive partners: good genes but poorer fathering quality. We set out to investigate for the first time, whether actual parenting quality was associated with fathers' facial measurements using structural masculinity, perceived masculinity and fWHR.

We hypothesised that men with wider faces would be worse fathers, which would be demonstrated by men with higher fWHR having lower NFS scores. However, we found no relationship between the two in our data. This is despite the wide range of variability in both fWHR (i.e. both very small and very high fWHR) and fathering ability (scores ranged from 7-35).

While males with higher fWHR may be healthier and more likely to be of high status (Stirrat & Perrett, 2010), the trade-offs can be large: research has linked high ratios to aggressiveness, deception, and being less faithful and investing as fathers (Carre & McCormick, 2008; Johnston et al., 2001). fWHR has been suggested to be linked with trust in male faces: low ratio faces are perceived as more trustworthy (Stirrat & Perrett, 2010), however we find no link between fWHR and fathering ability.

We did not find evidence that higher structural masculinity indicated less nurturing fathers; if anything, our results pointed in the opposite direction when looking at discriminant masculinity, with our data showing a positive relationship between discriminant masculinity and NFS scores indicating that more masculine men were better fathers.

The vast majority of the prior research suggested that masculine men should offer good genes, but prove poorer at fathering. This tends to be based upon lab experiments in which women rate unfamiliar masculine males as poorer parents. Our research was more ecologically valid than a lab-based activity, using real-life couples and fathers, looking at actual fathering abilities rather than perceptions. In addition, these fathering

abilities were rated by the father himself, and two people who know the father exceptionally well and generally had high agreement with their ratings.

A positive correlation was found between vector masculinity and fWHR, suggesting that as face width increased, masculinity increased. This seems to match the literature, which tends to indicate that in rating tasks, wider faces are perceived to be more masculine by women (i.e. Fink, Neave, & Seydel, 2007). Lefevre et al. (2012) concluded that fWHR is not consistently associated with other morphological measures of masculinity in facial structure. Indeed, we find evidence to support this, as perceived masculinity had no relationship to objective measures of facial morphology, nor fathering ability. This leads us to suggest that future research should avoid using perceived masculinity and structural masculinity interchangeably, at least until further work has been conducted than our admittedly small sample size of masculinity raters.

The photographs we used were of the fathers in the present day, not when the father and mothers first met. Due to procedural difficulties in guaranteeing quality, using old photographs was not feasible. Additionally, parenting behaviour was not objectively judged and was reported retrospectively. However, agreement between fathers, mothers, and daughters was high, which supports accurate recall. Further, theoretically these findings should be universal; however, we only investigated white British participants.

Close replication would be highly desirable to strengthen the findings (Zwaan, Etz, Lucas, & Donnellan, 2018), as would investigating cross-cultural generalisability. One key issue that should be disentangled by future research is whether participants can perceive the differences between high fWHR and masculinity. This could explain some of the conflicting research regarding masculinity and poor fathering abilities. This is an issue with perceived traits or appearances, and thus the novelty of using objective measures of such traits, as used in the present study, should be encouraged further. Additionally, a current theory is that males who can express their masculinity in additional ways, such as high-status careers, have fewer qualms about displaying care for their

children (Hanlon, 2012). While we did not collect any demographics about social economic status from the participants, it is certainly something for future research to consider. On a similar vein, it could be investigated whether the NFS is accurately measuring parental investment and not missing any traits or behaviours that make a good father.

This research suggests that the trade-off between genetic quality and parental investment may not centre on perceived masculinity as previously thought, nor fWHR. We find novel data lending itself to replication in samples investigating if the relationships between fathers and sons can be predicted by discriminant masculinity, or if it is purely found in fathers and daughters. Similarly, facial adiposity has also been found to artificially inflate fWHR (Lefevre et al., 2013) and as such, future studies should take into account BMI and adiposity.

If the lack of relationship found between perceived masculinity and parenting ability can be replicated, this would bring into question much of the theories surrounding women's trade-offs, cyclical preferences and short-term preferences, in addition to the leading theory that masculine males are poorer parents. We find no evidence for this, and indeed, find some evidence that daughters can confide in and become more emotionally close to masculine fathers.

Chapter 3: Self-love is the best love? Physiological and self-report measures of disgust and self-similarity

Introduction

This chapter will focus on the link between disgust and incest in humans. As previously mentioned in chapter one, inbreeding costs are high, and thus we should have evolved to avoid inbreeding at all costs to increase fitness (e.g. Bateson, 1983; Seemanova, 1971). This chapter will begin with a review of the different categories of disgust, followed by a recap of self-similarity in romantic partners, finishing with the aims of the present study.

Disgust was theoretically discussed by Darwin (1872, 1965), who postulated that disgust referred to anything revolting which related to taste, while Freud (1905) expanded the concept of disgust as taste related, and postulated that disgust helped to restrict sexual fantasies to only socially acceptable practices. Tomkins (1963) however, proposed that disgust was a reaction to unwanted intimacy. The origin of the evolution of disgust is not clear, and may not have a singluar function. Authors do agree that disgust is different from distaste: distaste being a type of food rejection motivated by sensory characteristics, for example, taste or smell. Conversely, disgust, while similar to distaste, is motivated by perceptions of threat, for example, contamination (Rozin & Fallon, 1987), and has been described as the “emotion of repulsion” (Cameli, Folgieri, & Carrion, 2016, pg 392). Disgust follows the laws of sympathetic magic: contagion and similarity (Rozin & Fallon, 1987). Contagion describes the reluctance to touch an AIDs patient’s cup for fear of infection, while similarity refers to the unwillingness to drink juice stirred with a brand new fly swatter- the similarity of the never used fly swatter is too close to the image of flyswatters covered in dead insects (Rozin, Millman, & Nemeroff, 1986).

Types of disgust

Scholars are unclear as to how to categorise disgust. Some use seven types: food, animals, body products, sex, body envelope violations, health, and hygiene (Haidt,

McCauley, & Rozin, 1994). Others use four main categories: core disgust (food, animals, body products), animal reminder disgust (sex, death, hygiene, body envelope violations), interpersonal disgust (dehumanized people or groups), and moral disgust (Rozin, Haidt, & McCauley, 2000). Here, I briefly discuss the subtypes of disgust using Chapman & Anderson's (2012) description of moral disgust, and disease avoidance (core disgust, blood injury and interpersonal, and sexual disgust).

Moral

Moral disgust is elicited through sociomoral transgressions, for example, murder, theft, fraud, and lying (Rozin et al., 2000). Moral transgressions “leave a bad taste in the mouth” of individuals (Chapman, Kim, Susskind, & Anderson, 2009, pg1222), and have been found to activate the disgust specific *levator labii* muscle, usually characteristic of an oral-nasal rejection response (Chapman et al., 2009).

Disease avoidance

Disease avoidance includes reactions that exist to avoid pathogens, infections and toxins, and covers blood-injury and interpersonal disgust, core disgust, and sexual disgust (Chapman & Anderson, 2012).

Blood-injury & Interpersonal

Blood-injury-injection (BII) covers the disgust, and often anxiety, of injuries, blood, and bodily deformities. BII also covers interpersonal disgust: the repulsion of contact with diseases and unfamiliar individuals. As the skin is the largest organ in the body (Sand et al., 2009), the potential for infection is huge. Skin to skin infection transmissions can occur through cuts and wounds, particularly those that seep blood or pus, and those infections not directly passed through skin-to-skin contact can enter other parts of the body. For example, conjunctivitis can be caught through faecal matter entering the eyes from the hands (Okoh, Sibanda, & Gusha, 2010). BII disgust can result in BII phobia, often symptomatic of proneness to fainting, however, is characterised by facial expressions of disgust, rather than fear, as with many phobias (Kleinknecht & Lenz, 1989; Lumley & Melamed, 1992).

Core disgust

Although many pathogens are microscopic, there are properties reliably related to their presence: for example, colour can indicate whether the fruit is unripe, ripe, or rotten (Tybur, Lieberman, Kurzban, & DeScioli, 2013). The presence of maggots, flies, and worms indicate how long a body has been dead, thus indicating a greater probability of bacterial contamination (Tybur et al., 2013). The disgust provoked by faeces and vomit tends to be a cross-cultural phenomenon (Olatunji & Sawchuk, 2005), and effort is made to remove these bodily products to avoid their presence (e.g. flushing a toilet). A common analogy in the disgust literature related to core disgust is that of a piece of fudge shaped like dog faeces. Individuals can understand that it is edible, but the association to dog faeces can lead to avoidance.

Sexual

Sexual contact can be very risky. Diseases can be easily spread through bodily fluids, tissue damage during intercourse, social risks through reputational damage, and for women, the reproductive load of becoming pregnant. These risks touch upon several types of disgust: pathogen transmission, genetic risks, and moral admonition (Strohminger, 2014), and as such, sexual disgust is suggested to be a preventative measure to protect against sex with no reproductive benefits (Tybur et al., 2013).

Sexual disgust is provoked through acts such as contact with the very young, or the very old, sex with another species (bestiality), and incest. Each of these groups could have the consequence of reproductive cost or lack of benefit. For example, sex with the very young or very old holds no reproductive benefits, as it would be unlikely for either age group to be fertile. As mentioned in chapter one, the most reproductively dangerous behaviour is incest. Disgust at the prospect of mating with a parent seems to act to avoid inbreeding (Lieberman, Tooby, & Cosmides, 2007). The severe costs associated with inbreeding can challenge fitness and reproductive success in humans through the increased probability of the expression of a recessive deleterious gene- evidence illustrates the increased risk of infection and mortality (Bittles & Neel, 1994), and congenital malformation or genetic diseases.

Physiological and neurological correlates of disgust

Disgust seems to be mediated by the parasympathetic branch of the autonomic nervous system (Levenson, 1992). Parasympathetic activity includes reductions in heart rate, blood pressure, respiration rate, and skin temperature, as well as increased salivation (Curtis & Thyer, 1983; Friesen, Levenson, & Ekman, 1990; Sledge, 1978; Zajonc & McIntosh, 1992). Differentiation of disgust from other negative affective states can be difficult due to shared activation of different brain regions: the amygdala, basal ganglia, hippocampus, orbitofrontal cortex, and the occipital-temporal cortices (Adolphs, 2002). However, the insular cortex is thought to be unique to the processing of disgust facial expressions (Calder, Keane, Manes, Antoun, & Young, 2000; Calder, Lawrence, & Young, 2001).

The facial expression of disgust is well documented: furrowing of eyebrows, closure of eyes and pupil constriction, wrinkling of the nose, upper lip retraction, upward movement of lower lip and chin, and the corners of the mouth drawn up and back (Levenson, 1992; Vrana, 1993). Wrinkling of the nose tends to be associated with offensive or irritating smells and somewhat related to bad tastes, while gape and tongue extrusion are associated with bad tastes or oral irritation. The raised upper lip relates more to body envelope violations, inappropriate sex, moral offences and aversive interpersonal contacts (Rozin, Lowery, & Ebert, 1994).

The physiology behind the latter disgust expression comes primarily from activation of the *levator labii superioris* (LLS) muscle (See Figure 5). Measurement of the LLS activation is conducted using electromyography (EMG), an experimental technique that records and analyses myoelectric signals, formed by physiological variations in muscle fibre (Basmajian & De Luca, 1985).

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Figure 5: The levator labii superioris muscles highlighted in red (InnerBody, ND)

Disgust responses measured by activation of this muscle correlate with scores on the Disgust Scale-Revised (r = .43), indicating good validity (Olatunji, Haidt, McKay, & David, 2008), and inducing disgust, but not anger, increased LLS activity, showing a unique link between the LLS and moral disgust (Whitton, Henry, Rendell, & Grisham, 2014). Further studies found increased LLS activity in response to purity violations (the desire to protect the purity of body and spirit by condemning or avoiding physical contamination) (Cannon, Schnall, & White, 2011), and increased LLB activity as a response to photographs of contaminants, and moral disgust (Chapman et al., 2009).

Self-report measures of disgust

Using physiological measures alongside self-report measures of disgust should be preferred due to issues relying on self-report alone. Firstly, self-report measures may not distinguish between disgust and other negative affective states, such as anger, as English speaking participants seem to use the words “disgust” and “anger” interchangeably (Chapman & Anderson, 2013). In addition, ceiling and floor effects are often seen, for example, mild violations (e.g. being five minutes late for a meeting) compared to severe violations (e.g. murdering two people in their own home) (Olatunji & Puncochar, 2016).

However, self-report scales do have benefits, particularly those that have been validated and tested many times. The most commonly used scale is the 32-item Disgust Scale (DS) (Haidt et al., 1994), which measures disgust across seven domains (food, animals, body products, sex, body envelope violations, death, and hygiene) and magical thinking in a true-false format (e.g., I avoid touching doorknobs in public places), or scale answer. However, following concerns due to inadequate items and Cronbach alpha estimates (See Schienle, Stark, Walter, & Vaitl, 2003), the Disgust Scale was tested and revised (Olatunji et al., 2007). Analysis confirmed that some items failed to perform adequately,

and could be detracting from the overall score, and that a three-factor model (core disgust, animal reminder disgust, contamination disgust) with 25 items scored with Likert scales was a better fit to the data than the original eight-factor model, and had adequate internal consistency (all α's > .70). Scores on the Disgust Scale-Revised (DSR) correlated highly with original DS (*r* = .89), with the authors finding that the DSR retained many of the qualities of the DS, but with improved psychometric properties and sounder factor structure. The DSR has since been tested cross-culturally, translated into many languages, and tested in clinical populations successfully (Haidt et al., 2009; Olatunji et al., 2007; van Overveld, de Jong, Peters, & Schouten, 2011).

Disgust and Self-Similarity?

Cues of kinship can help individuals avoid the danger of inbreeding. As mentioned in Chapter One, the Westermarck effect postulates that humans develop a sexual aversion to those we are related to, or look similar to those we are related to (Rantala & Marcinkowska, 2011; Westermarck, 1903). For example, DeBruine (2005) showed participants self-similar faces as a proxy for relatedness and found that facial resemblance increased judgements of trustworthiness, and decreased attractiveness in the context of a short-term relationship, with this effect replicated in Zhuang, Zhang, Xu, & Hu (2014). Similarly, more work found a preference for dissimilar faces but only in single individuals. Participants in relationships did not show this effect, which makes sense given that single individuals are actively looking for a partner, and avoiding inbreeding costs is useful (Lindova et al., 2016), particularly given that other studies conclude that coupled participants seem to pay less attention to cues of sexual attractiveness (e.g., Koranyi & Rothermund, 2012). However, other studies have found self-similar faces were preferred to other morphed faces (Saxton, Little, Rowland, Gao, & Roberts, 2009; Sulutvedt & Laeng, 2014), or that men preferred self-resembling faces to non-resembling ones in opposite-sex faces (Bovet et al., 2012; Kocsor et al., 2011). However, these methods are based entirely on self-reported ratings, with no objective measures of disgust towards self-similarity.

Aims

The aims of this study were to replicate the findings that some self-similarity is attractive when thinking about passionately kissing an opposite-sex composite morphed to look self-similar. None of the above studies incorporates both self-report and physiological measures of disgust, and thus we aim to add to the mixed literature by adding an extra level of objective measurement for the first time, in the form of facial electromyography.

Method

Participants

We recruited 48 females aged between 18-35 years old who were sexually attracted to men (mean age 22 years, SD = 3 years). Participants were recruited through opportunity sampling among undergraduate students at a university in England. All participants provided informed consent and confirmed they had no relevant allergies (so participants did not have any reactions to the EMG conductivity solution). Sample size was not based on power calculations but reflected the number of participants we were able to recruit in the timeframe given for this project. Ethical approval was granted from the University before recruitment began, and all participants were granted either £10 cash or Amazon voucher for their time.

Materials and Procedure

Photographs

All participants came into the lab a few days before their main testing session, under the guise of us needing to take a photograph of their neutral face as a baseline for the EMG analysis. Photographs were taken in the same room, with the same lighting, with the camera at a distance of 1 metre. The camera used was a Canon EOS 80D (W), with flash disabled. Photographs were 24.2 pixels. All hair was pushed out of the face with a hairband and participants wore minimal makeup (if any).

Morphing

The photos taken of participants were then morphed using Webmorph (DeBruine, 2017). 189 landmarks were delineated on each face. 20 male base faces (DeBruine & Jones, 2017) were then transformed to be less like an average female (made up of 20 female faces; DeBruine & Jones, 2017), and more like the participant in differing degrees (20%, 40%, 60%, 80%, see Figure 6). Photographs were then masked of hair and ears, leaving just the oval of the face and neck on a black background. Photographs were displayed at 675 x 900 pixels. Four female participants were recruited to rate the attractiveness of each participant's 40% and 80% morph to ensure all morphs were of similar levels of attractiveness.

Figure 6: Top line: A male base face, an average female, and a participant. Morphs make the male less like the average female and more like the participant. Bottom line: 20% similarity, 40%, 60%, 80%

Questionnaires

We used the Disgust Scale-Revised (DS-R) and the General Anxiety and Depression 7 (GAD-7) (Spitzer, Kroenke, Williams, & Löwe, 2006) questionnaires to collect a baseline of each participant's disgust threshold and anxiety levels, which typically correlate, although in our sample, did not: $r_s = 0.130$, $p = 0.394$. The DS-R consists of 25 questions and 2 filler questions. The first 14 are answered on a scale from 0-4, where 0 is strongly disagree and 4 is strongly agree, for example "*It bothers me to hear someone clear a throat full of mucus*". The latter 13 are answered using 0-4 where 0 is not disgusting at all and 4 is extremely disgusting, for example "*You are about to drink a glass of milk when you smell it is spoiled*". Participants completed these at the start of the test session. Reliability analysis found the DS-R to be of acceptable internal consistency overall (α = .791). Reliability of the GAD-7 was good: α = .856.

Tasks

The task was coded using the PsychoPy libraries in Python 2.7 (Peirce, 2007). Participants saw 5 blocks of images in a serial, randomised order, the original 20 male faces, and then the transformed faces at 20, 40, 60 and 80% similarity. Participants were told to imagine passionately kissing each person and asked to rate on a 7-point scale how they would feel, from excited to disgusted, with a neutral option. Images were shown until participants selected a response, and then a black screen with fixation point was shown for 2 seconds. Participants had a short break between each block. Participants then completed a forced choice task without accompanying EMG, where they saw every manipulation of each base face. For example, participants would see Face A in each combination: original face vs. 20%, original face vs. 40%, original face vs. 60%, original face vs. 80% etc. Participants had to select which face they would prefer to passionately kiss. The images were shown until the participant chose an image via keypress, and then a black screen with a fixation cross was shown for 2 seconds before the next screen started.

EMG

Facial EMG was used to measure individual differences in disgust responses to the first facial stimuli task (serial, randomised order). Expressions of disgust centre around the *levator labii superioris* muscle and activity in this muscle is correlated with responses to the Disgust Scale. To prepare for electrode placement, the skin around the *levator labii superioris* and forehead (ground electrode) was cleaned with alcohol wipes and then to enhance conductivity, NuPrep gel was rubbed over the areas. Two 4mm gold plated bipolar surface electrodes (AD Instruments) were placed on the LLS with an inter-electrode distance of 10mm (See Figure 7). Each electrode was filled with Signa Crème electrode cream to aid conductivity and secured with surgical tape.

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Figure 7: Yellow circles showing where the active electrodes were placed, green signifying ground electrode (InnerBody, ND).

Muscle activity was monitored constantly during the first task using an AD Instruments PowerLab 26T at a rate of 2kHz. Event markers were entered into the data stream using LabChart 8 detailing when each block started and ended for the purposes of analysis. The range for EMG activity was set at 500µV, with a low pass filter of 1 kHz and a high pass filter of 10 Hz. See Figure 8 for raw data example.

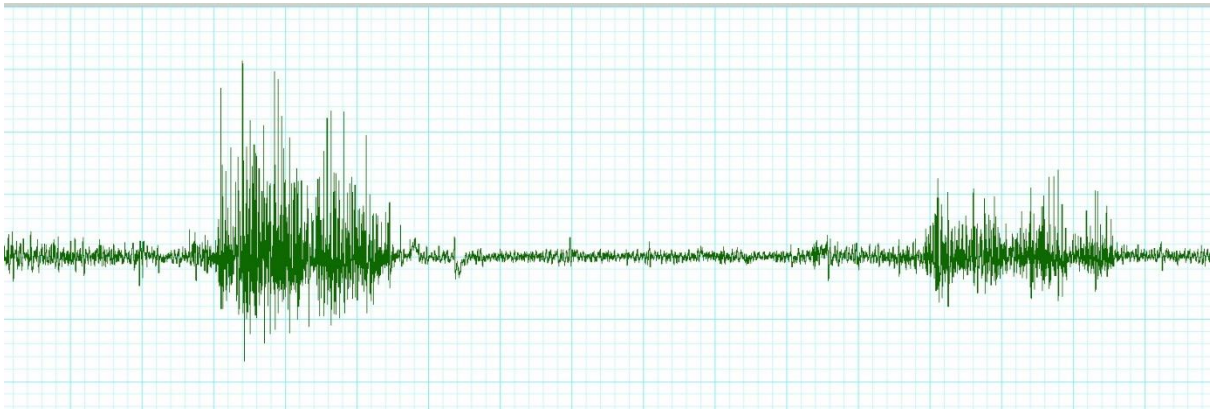

Figure 8: Raw EMG data showing disgust response

EMG Processing

EMG data was processed using MATLAB 2019a (MathWorks, 2019) in two different ways. Firstly, participants' responses in the original responses were analysed on a participant-by-participant basis, and the percentage of muscle activation higher than two SDs of the mean of that trial was recorded (Weber et al., 2017)(See Figure 9).

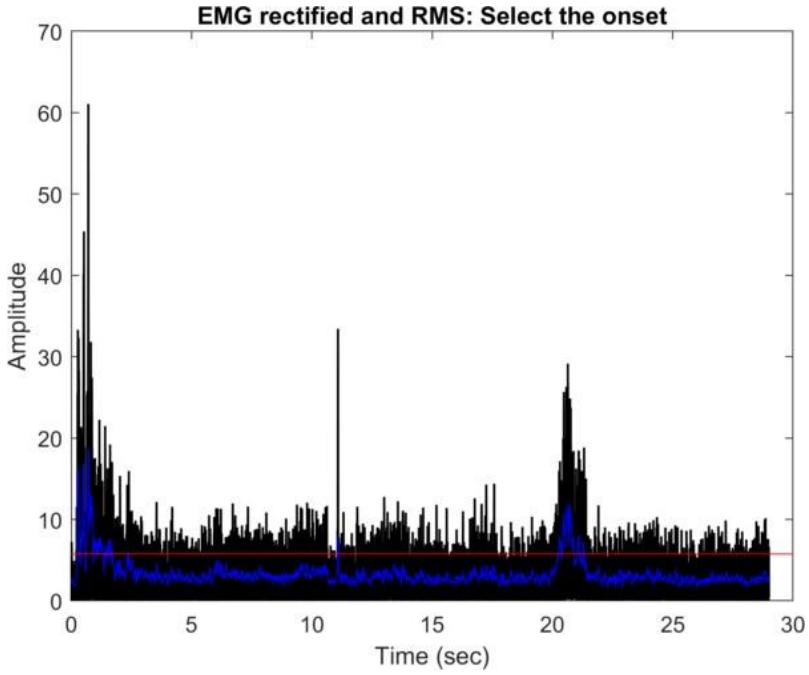

Figure 9: Red line: Two SDs above the average activity, whole trial analysed

This was then compared to the experimental trials, where any muscle activation higher than that participant's non-manipulated trial was recorded as a percentage change. After processing, we were left with a percentage for the 0% condition, and then percentages for how much higher each experimental trial was than the 0% (see Table 3).

Table 3: The percentage of activity per manipulation for each participant. Missing data due to signal issues.

0%	20%	40%	60%	80%
2.50	5.48	4.72	2.79	5.35
4.19	1.77	2.37	3.64	2.11
2.80	1.43			1.51
4.02	3.72	1.40		2.28
3.31	6.81		4.81	4.91
4.11	1.21	1.39	1.66	1.28
4.83	4.87	6.48	2.52	2.96
4.29	2.96	9.68	1.13	6.84
3.37	4.54	6.33	4.89	1.54
4.89	6.71	7.22	1.90	
4.77	7.37			
4.45	4.84	6.63	1.90	3.70
2.82	7.65	5.02	4.26	6.12
4.58	3.27	6.61	2.81	8.93
4.83	2.86	1.70	5.83	
4.64	3.83	4.48	6.45	
3.47	2.32	2.28	4.21	2.31
3.80	8.64	6.10	5.28	7.85
2.44	7.75	1.63	1.67	1.97
2.39	1.73	9.41		2.01
4.12	8.24	5.89	4.63	
3.86	6.23	3.98	6.22	5.08
4.33	1.26	7.35		9.37
2.63	4.80	5.19	1.34	1.01
1.55	2.50	3.49	3.27	2.13
4.16	1.23	1.70	1.54	2.31
4.13	7.29	5.45	5.27	1.26
4.65	3.81	6.11	3.51	1.18
4.45	6.42		1.05	5.08
4.45	1.03	4.41	5.85	4.08
4.49	5.33	5.49	5.60	
4.48	5.48	9.00	3.30	3.74
2.29	2.21	7.41	4.72	1.10
3.86	5.16	3.80	2.27	7.58
4.45	1.45	6.81	2.51	3.43
4.59	1.67	9.64	1.00	1.43
3.73	1.72		2.39	1.11

Because this method was quite generalised, and did not specifically look at individual responses or trials, we chose to further break the data into trial epochs. As we did not record exact trial onsets and offsets, we approximated each trial as beginning 1000ms before a registered key press, and ending 250ms following that keypress. This resulted

in 100 epochs from each participant (see Figure 10). The rationale for choosing the 250 millisecond cut off was because this was when the fixation screen loaded. Some data had to be excluded at this stage due to poor quality signal in the data (13 participants lost one trial, one lost two trials, one lost three trials, and five lost all trials).

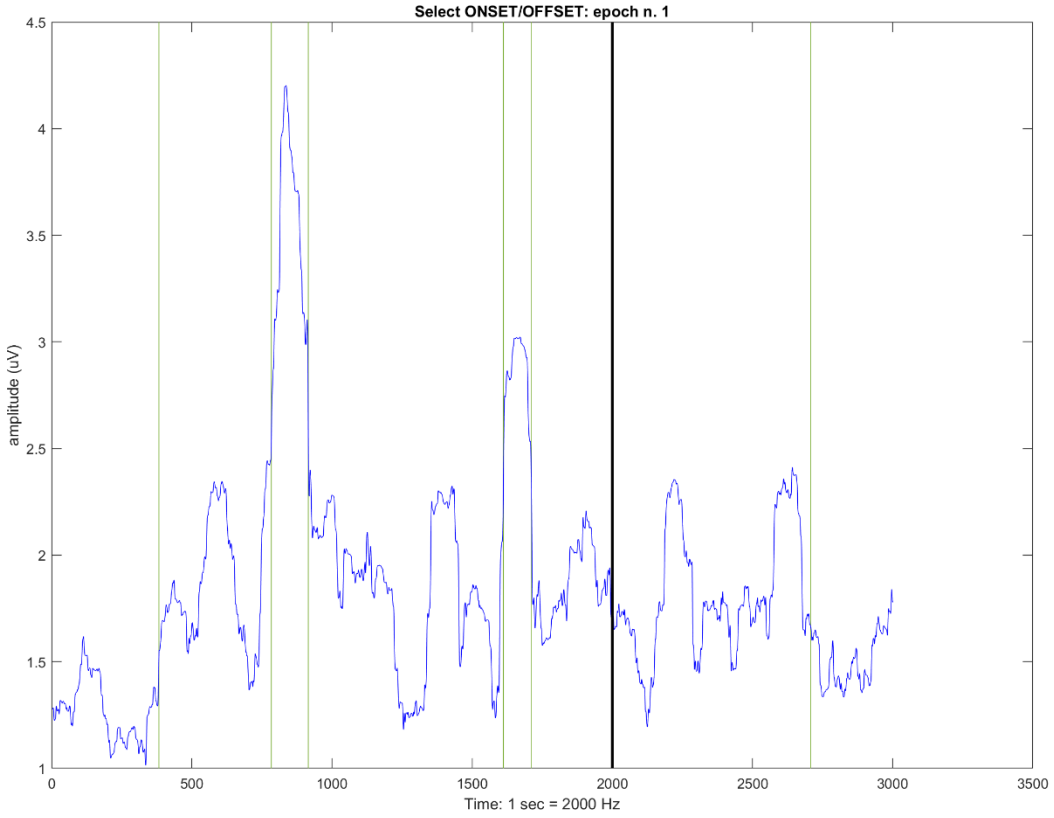

Figure 10: Individual trial data, black line = key press

Results

Descriptive Statistics

Mean GAD-7 score was 9.06 (SD = 4.79) out of 28 (range 0-20). For comparisons sake, scores of 0-9 are classified as mild, 10-14 moderate, and >15 severe symptom severity (Spitzer et al., 2006). Mean DS-R score was 2.19 (SD = 0.48) out of five, range (0.92 – 3.04). Self-report ratings of disgust correlated with both physiological measures of disgust (AUC: r_s =0.125, p < .001, 95% CI [0.089, 0.161]; maximum amplitude: r_s = 0.134, p < .001, 95% CI [0.097, 0.168]). The attractiveness scores from the four raters ranged

from 1.84/7 to 2.39/7, therefore we accepted that the attractiveness of each participant morph was comparable. See Table 4 for individual ratings.

Table 4: Mean attractiveness scores of the participants morphs, 1 = very unattractive, 7 = very attractive

ID	Mean Attractiveness (SD)
4	2.07 (0.69)
5	1.97 (0.58)
7	2.39 (0.71)
8	1.93 (0.60)
9	2.19 (0.64)
10	1.93 (0.69)
11	2.13 (0.61)
12	2.02 (0.62)
13	2.16 (0.72)
14	2.24 (0.68)
15	2.10 (0.74)
16	1.95 (0.56)
17	1.91 (0.65)
19	2.05 (0.54)
22	1.93 (0.57)
23	1.92 (0.71)
24	2.03 (0.61)
25	1.98 (0.64)
30	2.04 (0.64)
31	2.05 (0.65)
32	2.04 (0.69)
33	2.21 (0.58)
35	2.23 (0.44)
36	1.84 (0.68)
37	2.09 (0.75)
38	2.36 (0.56)
39	1.84 (0.64)
50	1.99 (0.66)
53	1.99 (0.44)
54	2.21 (0.67)
55	1.86 (0.58)
56	2.31 (0.70)
58	2.07 (0.77)
60	2.13 (0.57)
65	2.20 (0.49)
71	2.10 (0.62)
73	1.91 (0.60)
77	1.96 (0.62)
78	2.00 (0.60)
79	2.18 (0.67)

Self-report Analysis

Descriptive statistics showing the mean ratings for levels of disgust for each level of transformation can be found in Table 5 and Figure 11.

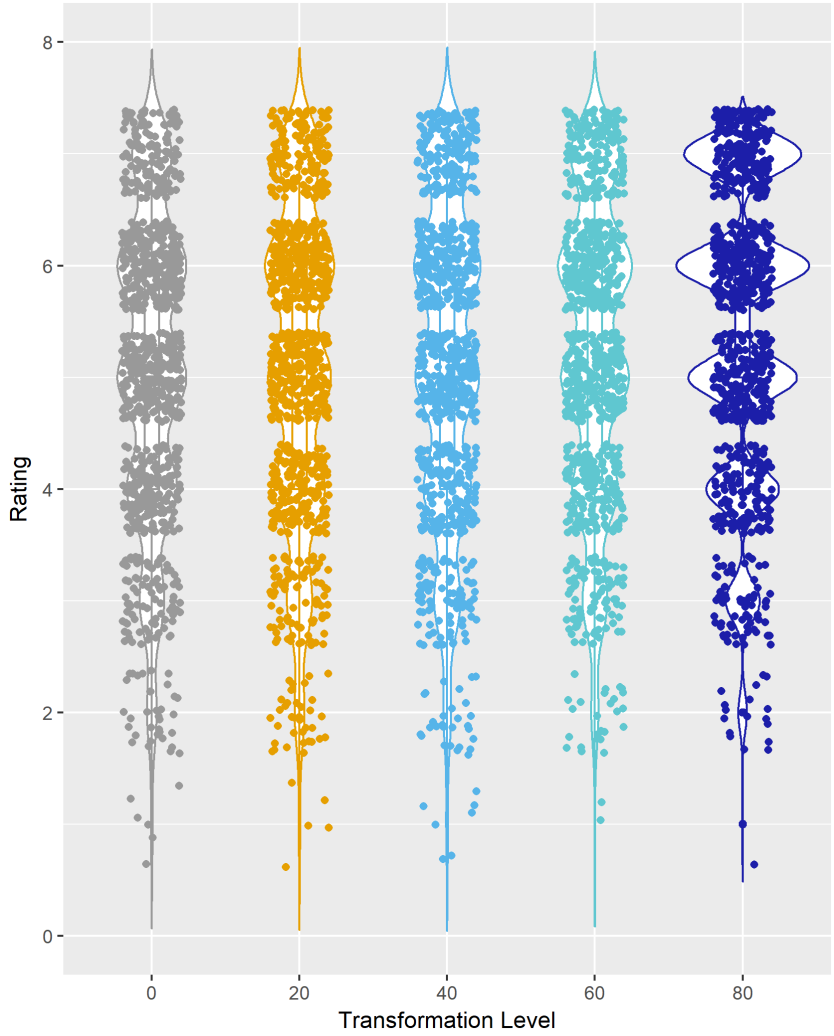

Figure 11: Distribution of self-report ratings across each level of transformation: 1 = excited to passionately kiss the man, 7 = disgusted at kissing each face

Table 5: Mean and SD for self-report ratings of disgust (1 = excited to passionately kiss the man, 7 = disgusted). Higher scores indicate higher levels of disgust.

Similarity Level of morphed face	Mean Rating (SD)
Original	5.047 (0.896)
20%	5.065 (0.866)
40%	5.105 (0.970)
60%	5.195 (0.907)
80%	5.417 (0.932)

As Table 5 illustrates, disgust ratings were higher in the 80% morphed condition, and lowest in the original faces condition.

A linear mixed model was conducted to predict disgust self-report using package nmle in R (Pinheiro & Bates, 2015). Outcome variable was disgust rating while the explanatory variables were DSR and GAD7 scores, and participant was added as a random intercept. Change in model fit was judged on change in AIC/BIC/LL figures (see Table 6).

Table 6: Multilevel model with rating of disgust as DV

	Model 1	Model 2	Model 3	Model 4
DSR			0.413	
			(0.249)	
GAD7				-0.011
				(0.023)
Transformation		0.004***	0.004***	0.004***
		(0.001)	(0.001)	(0.001)
Constant	5.166***	4.992***	4.087***	5.091***
	(0.126)	(0.128)	(0.558)	(0.241)
N	4,698	4,698	4,698	4,698
Log Likelihood	-7,027.214	-6,995.164	-6,993.796	-6,995.047
AIC	14,060.430	13,998.330	13,997.590	14,000.090
BIC	14,079.790	14,024.150	14,029.870	14,032.370

*p < .05; **p < .01; ***p < .001

As is traditional in linear mixed models, we begin with an empty model that consists of only the intercept term (Model 1) and build models up gradually from there one term at a time. Model 2 entered transformation level as a fixed factor and participant as a random factor (intercept only). Models 3 and 4 additionally contained DSR and GAD7

respectively. However, we found that neither the DSR, nor the GAD7 made a significant contribution to model fit and were therefore not included. Therefore, according to our fit criteria, model 2 was our best fitting and final model. This model indicates that the level of transformation of the face being judged was a significant predictor of participants' disgust rating, and that the individual differences between participants was significant (i.e. there was significant variation between participants in the way they rated each face, some rating them higher or lower overall), $b = 0.004$, 95% CI [0.003, 0.005], $p < .001$, $R^2 = 0.008$. Log likelihood, AIC and BIC changes from model one to model two (Δ AIC = 62.1, Δ BIC = 55.64, Δ LL = -32.05) were significant at the level of $p < .001$ based on critical value of chi-square distributions.

Physiological Data

After the physiological data was processed, the first analysis that was conducted looked for significantly increased muscle activation to the morphed faces compared to the non-manipulated faces. We recorded the percentage of activity to the non-manipulated face that was higher than two SD's above the mean activity of that trial, and then cross-referenced that figure to the experimental trials, where we recorded the percentage of activity that was higher than the mean reaction to the non-manipulated face. Descriptives can be found in Table 7.

Table 7: Mean (SD) of percentage of muscular activity > 2 SDs above baseline

Similarity level	Mean Percentage
0%	3.86% (0.87)
20%	4.21% (2.36)
40%	5.29% (2.46)
60%	3.44% (1.70)
80%	3.60% (2.49)

As a first pass, we conducted a repeated-measures ANOVA to establish whether at a group level there was a systematic increase in electrical activity as a function of facial similarity. This analysis showed the percentage of activity significantly differed by transformation level: $F(4, 92) = 4.090$, $p = 0.004$, however pairwise comparisons showed that this was driven by the 40% condition, which was significantly different to 0% (p =

0.036) and 60% (p = 0.028). However, we also conducted a more in-depth analysis that allowed for individual differences and trial specific effects.

The following analyses investigated each response from every photo participants saw. Muscle activation, shown using data from the area under the curve, and data from the maximum amplitude of each response suggested that in both forms of analysis, highest activation was in the 80% condition as expected (See Table 8 and Table 9).

Table 8: Mean and Standard Deviation for mean area under the curve (AUC) physiological data

Similarity Level	Mean AUC (SD)
Original	5888.52 (4519.41)
20%	5489.69 (4568.88)
40%	6479.78 (5899.54)
60%	6776.88 (6533.75)
80%	7753.93 (6442.64)

Table 9: Mean and SD for maximum amplitude by condition

Similarity Level	Mean Max. Amplitude (SD)
Original	6.43 (5.01)
20%	6.51 (5.42)
40%	7.38 (6.48)
60%	7.74 (7.46)
80%	8.92 (7.19)

Next, multilevel models were run, one with AUC as the outcome variable (Table 10), and one with maximum amplitude as outcome variable (

Table 11). Due to extreme outliers, the package DescTools (Signorell, 2019) was used to normalise outliers, using the Windsorize function. As with the previous multilevel model we built these gradually and assessed model fit. We added transformation level, DSR and GAD7 as fixed factors, and participant was used as a random factor.

Table 10: Multilevel model with area under the curve as outcome variable

	AUC			
	Model 1	Model 2	Model 3	Model 4
DSR			-168.516	
			(988.494)	
GAD7				15.809
				(85.225)
Transformation		80.011	80.076	80.145
		(45.209)	(45.218)	(45.222)
Constant	6,425.238***	6,189.189***	6,559.032**	6,046.999***
	(499.069)	(514.587)	(2,229.629)	(924.551)
N	2,990	2,990	2,990	2,990
Log Likelihood	-28,683.160	-28,681.600	-28,681.580	-28,681.580
AIC	57,372.330	57,371.200	57,373.170	57,373.160
BIC	57,390.340	57,395.210	57,403.180	57,403.180

*p < .05; **p < .01; ***p < .001

Table 11: Multilevel model with Maximum Amplitude as outcome variable

	Max. Amp			
	Model 1	Model 2	Model 3	Model 4
DSR			-0.052	
			(1.048)	
GAD7				-0.037
				(0.090)
Transformation		-0.024	-0.024	-0.024
		(0.048)	(0.048)	(0.048)
Constant	7.193***	7.265***	7.378**	7.601***
	(0.526)	(0.546)	(2.363)	(0.973)
N	2,990	2,990	2,990	2,990
Log Likelihood	-8,191.021	-8,190.892	-8,190.891	-8,190.807
AIC	16,388.040	16,389.780	16,391.780	16,391.610
BIC	16,406.050	16,413.800	16,421.800	16,421.630

*p < .05; **p < .01; ***p < .001

None of the models fitted well with maximum amplitude nor AUC as an outcome variable, with neither DSR, GAD7, nor Transformation levels making any significant reductions in the LL, AIC or BIC.

Forced-Choice Analysis

For the forced-choice data, we calculated the frequency for each similarity percentage chosen as the one participants would prefer to passionately kiss. These were totalled in Table 12.

Table 12: Frequency table

Similarity Level	N
0	2054
20	2063
40	1838
60	1340
80	697

Due to the data being frequency data, a chi square analysis was performed to see if the frequencies were proportionately different: X^2 (4) = 850.929, p < .001, V = 0.326. This indicates that the faces preferred differ significantly in their similarity, with the faces that were 20% similar being picked most often, and the 80% faces being picked the least, with a medium effect size using Cramer's V. Cramer's V was calculated using the following formula (Cohen, 1977):

$$\sqrt{\frac{x^2}{\eta - df}}$$

Further chi square analysis were performed as post-hoc tests and can be found in Table 13.

Table 13: individual Chi-Square comparisons, Cramer's V classifications: 0.10 Small, 0.30 Medium, and 0.50 Large

Comparisons	Chi Square
0 vs. 20	$X^2(1)$ = 0.020, p = 0.888, V = 0.042
0 vs. 40	$X^2(1)$ = 11.988, p = 0.001, V = 0.055
0 vs. 60	$X^2(1)$ = 150.205, p < .001, V = 0.21
0 vs. 80	$X^2(1)$ = 669.374, p < .001, V = 0.243
20 vs. 40	$X^2(1)$ = 12.977, p < .001, V = 0.058
20 vs. 60	$X^2(1)$ = 153.608, p < .001, V = 0.212
20 vs. 80	$X^2(1)$ = 676.071, p <.001, V = 0.245
40 vs. 60	$X^2(1)$ = 78.038, p < .001, V = 0.157
40 vs. 80	$X^2(1)$ = 513.563, p < .001, V = 0.450
60 vs. 80	$X^2(1)$ = 202.970, p <.001, V = 0.316

All analyses were significant except the differences between 0 and 20% self-similarity.

All data and analysis can be found at the following link:

https://osf.io/r84j5/?view_only=c3587f454dfd431d94b6e47817bb39ef.

Discussion

Research suggests that many animals (humans included) have innate mechanisms to avoid mating with close kin to avoid the cost of inbreeding, and above a certain threshold, the more similar a potential partner looks, the more sexual aversion should be produced. We used self-report and physiological methods to gauge disgust to men's faces morphed to be varying levels of self-similarity, as a proxy for relatedness.

We hypothesised that self-reported levels of excitement-disgust would trend towards being more disgusted about the prospect of kissing an extremely self-similar man, so that above a certain level, disgust reports would be higher the more self-similar the men were. Descriptive statistics show that reported disgust was highest in the 80% self-similar men, and our model confirmed that level of transformation had a significant effect on ratings, with more self-reported disgust at the prospect of passionately kissing men with higher levels of self-similarity.

Similarly, in the forced-choice paradigm, we predicted that participants would pick the man with *some* self-similarity to passionately kiss, rather than a man *very* self-similar. Descriptive statistics showed that the faces picked the least were the 80% self-similar faces, and the most picked faces to passionately kiss were the 20% self-similar faces. However, chi-square analysis showed that there was not a significant difference between the rates of picking 0% and 20% self-similar faces. There was significant differences in all other levels however, with the least picked face in each pair the higher face in similarity. The biggest difference was 40% vs. 80% faces, with a medium-large effect size.

In terms of physiological data, we predicted more disgust responses during trials with higher similarity men. While descriptive statistics supported this notion with more activation in higher levels, neither model showed any significant effects of transformation

level and physiological response, and our broad analysis suggested significantly more activation of the disgust muscle only during the 40% similarity trials. Overall, we found expected results with self-report data, but failed to find significant comparable results using physiological measures, despite it being in the same direction. The self-report data supports previous research showing self-similarity above a certain level to be a turn-off for participants (e.g., DeBruine, 2005).

A potential limitation of this study was the EMG signal quality, frequently it contained 50Hz (mains) noise, and other artefacts. In future studies, we would isolate all electrical equipment, perhaps using a faraday cage, to avoid any interference on the EMG data. This chapter used all women participants: while this was a methodological decision since women, as the cost-bearer of childbirth, should be more attuned to the dangers of incest, it would be interesting to compare men's responses to the women's to see if they prefer a more self-similar partner. On that note, future research should also aim to investigate the responses given by non-heterosexual participants, as the disgust response produced based on the risks of inbreeding are not present in same-sex relationships. Finally, due to time constraints, the number of participants who rated the photos for attractiveness was small.

Chapter 4: I like the way you move: similarities and features of body language in couples.

Introduction

Having discussed the concept of couples looking alike, having similar personality types, and even genetic similarities, we speculated whether couples *moved* in a similar fashion. That is, to what extent do they mimic each other's body language?

While individuals can copy others with their speech and vocalisations, here we are interested in body language: hands, bodies, and facial expressions. This can be both conscious and unconscious. Critically, conscious, purposeful, and goal-orientated copying falls under the definition of imitation (Kinsbourne & Helt, 2011), whilst unconscious, automatic copying is defined as mimicry (Chartrand & Bargh, 1999), which will be the focus of this chapter.

The neural mechanism behind mimicry is thought to be mirror neurons, first found in macaque (*Macaca)* premotor and parietal cortices (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996), with similar structures found in humans (Molenberghs, Cunnington, & Mattingley, 2012). Mirror neurons fire on two occasions: when an individual performs an action, and when that individual sees that same action performed by another. One theory behind this process is that mirror neurons developed due to evolutionary pressure to understand other people, and that mimicry therefore enhances reproductive fitness (e.g., Arbib, 2010; Rizzolatti & Craighero, 2004). In contrast, the associative learning account (ASL) of mimicry postulates that associative learning forges the mirror neurons that support mimicry and imitations (Cook, Bird, Catmur, Press, & Heyes, 2014).

There is a plethora of research suggesting that people respond positively to being mimicked, and that mimicry increases prosocial behaviour (which lasts beyond the mimicking period, (Van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009)), feelings of affiliation, likeability, and being spontaneously helpful (Chartrand & Bargh, 1999;

Guéguen, Martin, & Meineri, 2011; Lakin & Chartrand, 2003; Van Baaren, Holland, Steenaert, & van Knippenberg, 2003). This effect shows evidence of beginning early in the life-span: 18 month old infants were more likely to help a researcher pick up pencils after they were mimicked, and mothers who mimicked their infants' facial expressions increased gaze engagement (Carpenter, Uebel, & Tomasello, 2013; Field, 1977).

The idea of benefits to mimicking behaviours can be traced back to at least the 18th Century, with Smith claiming that imitation was a form of sympathy (Smith, 1822). In the early 1930s, research demonstrated that participants had mimicked the body movements of the researcher who was reaching back and forth (Hull, 1933). More recently, mimicry is thought of as a social glue (Kavanagh & Winkielman, 2016), helping humans to bond and learn. Two possible functions of mimicry in this social glue theory is that mimicry has a communicative function, with a sender who does the mimicking, and a receiver who witnesses the mimicking of their own behaviour. A second function is that of reciprocity, in that mutual mimicry provides evidence that both parties are responsive, living, and of the same species (Farmer, Ciaunica, & Hamilton, 2018). However, individuals tend to decrease in mimicry towards people they initially dislike, and towards outgroup members, suggesting that social signals aid in who to mimic (Farmer et al., 2018). We mimic more when there is a connection to the other party, they are important, in order to affiliate, or are socially oriented (Van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009).

Typically, research investigates mimicry employing confederates trained to mimic behaviour, or, more recently, utilising virtual reality (VR) paradigms. Confederates can be watched on a video, while participants are observed for mimicking behaviours. One example is a confederate reading a story and wrinkling their nose, while participants are videoed and the amount of times they touched their nose noted (Genschow, Klomfar, Haene, & Brass, 2018). Confederates may also be observed face-to-face, for example, mimicking participants purposefully during a discussion about paintings (Guéguen et al., 2011), or describing photographs (Chartrand & Bargh, 1999). Using VR, studies have

showed participants a virtual avatar that mimics movement and gestures after a short delay, or measured how much participants mimic the virtual avatar (e.g. Hale & Hamilton, 2016; Latu, Mast, Bombari, Lammers, & Hoyt, 2019; Vrijsen, Lange, Dotsch, Wigboldus, & Rinck, 2010). These types of tasks are helpful to examine the feelings mimicry can produce, for example affiliation or helpfulness, but do not allow for the investigation of how people react to others, without confederates purposefully mimicking. Using observational methods in mimicry research allows us to see natural behaviour without any manipulations that may influence participants.

Aims

Because individuals seem to mimic others more when there is a connection and they like them, we predicted that couples would mimic each other more than strangers would. Telling couples apart from strangers may be useful to humans: knowing who is coupled with whom can help people allocate mating efforts efficiently. We know humans are well adept at identifying hostile and dominant body language, and wish to know if we can identify coupled body language. In order to investigate this sparse area of the literature, we created avatars of real couples and pairs of strangers using motion capture, a precise digitiser of motion, which allows us to scrutinise movement patterns without possible confounds like gender, height, weight and build.

Method

Participants

40 participants (22 F, 18 M) aged between 18 and 36 years old were recruited. Participants were either a romantically involved couple (N = 10, male/female couples = 8, 1 male/male couple, 1 female/female couple), or a pair of strangers (N =10, 2 male/male pairs, 4 female/female pairs, 4 male/female pairs). Both groups of participants were told they were taking part in a team-building task.

Activity

Couples were given the Couples Satisfaction Index-32 (Funk & Rogge, 2007), and completed the questionnaire in silence at opposite ends of the room, facing away from

each other. Completed questionnaires were immediately hidden from participants. Cronbach's alpha was α = .882. Mean CSI score was 142 (SD = 18.65, range 101- 161). The CSI scores within a couple did not differ significantly: $t(9) = 1.368$, $p = 0.204$, $d = 0.26$, and correlated strongly: $r = 0.792$, $p = 0.006$, 95% CI [0.538, 0.914].

Hardware

A 14-camera Vicon MX system running Nexus v2.7 software (Vicon, Oxford) was used to capture body movement. The system consisted of 12x T20, and 2x T40S cameras.

Participant measurements

Participants had several anthropometric measurements taken in order to build an accurate biomechanical model of their motion. The following measures were taken: height (mm, Seca stadiometer); weight (kg, Seca digital scales); leg lengths (mm, measuring tape); ankle widths (mm, callipers); knee widths (mm, callipers); elbow widths (mm, callipers); and wrist widths (mm, callipers).

Markers

Reflective markers were attached to participants in accordance with the Vicon Plug-In-Gait marker set (Figure 12). Thirty-nine 14mm round reflective markers were placed at major joint locations on the body, attached to the body with hypoallergenic tape. The Plug-In-Gait marker set has been validated by several researchers and provides accurate representation and output of movement (Bell, Pedersen, & Brand, 1990; Davis, Ounpuu, Tyburski, & Gage, 1991).

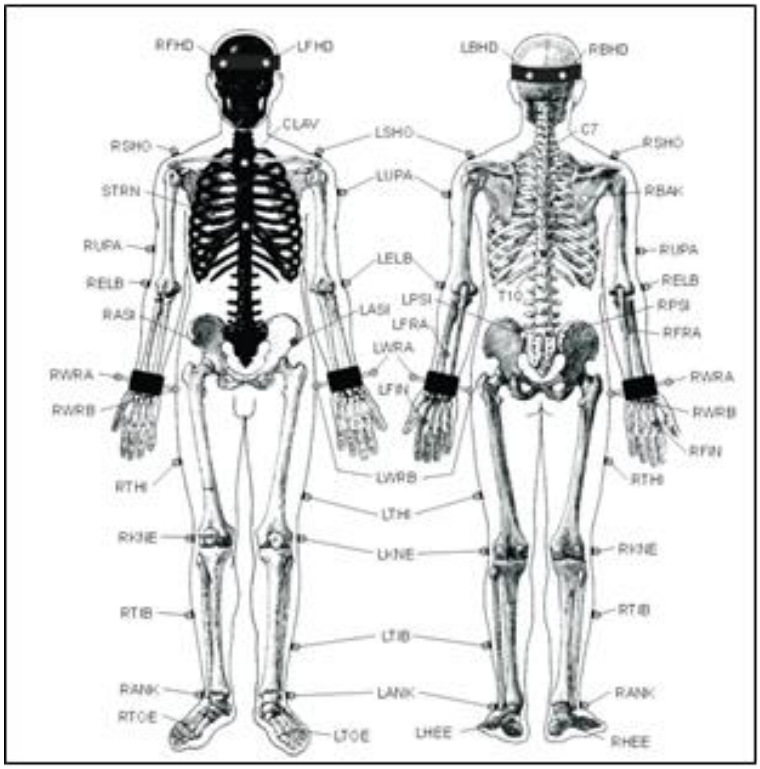

Figure 12: Plug-In Gait marker set layout showing the anatomical locations of each body marker (Vicon, Oxford)

To ensure accurate placement of the markers, participants were asked to wear shorts or leggings, and a tight-fitting t-shirt (See Figure 13).

Figure 13: Marker layout

Data Capture

Participants were asked to stand at the point of origin in the lab (the zero point of the reference grid), with one participant towards the back of the point of origin and one towards the front, both in a T-pose. A 600-frame snapshot was taken, and participants

were told to relax. This calibration snapshot was then labelled, to check for missing markers. If detected, the calibration was repeated.

Participants were told to face each other, and try to act as naturally as possible, given the constraints of wearing 39 markers. They were asked to debate between themselves, what they would do with £500 if the lead researcher were to give it to them in cash at the end of the testing session. They were told that the decision had to be mutual, and they were not allowed to split the money and take the cash. Participants took on average 168 seconds (SD = 62.63 seconds, range 120 – 300 seconds) to make a decision, however, if they decided in under two minutes, they were asked to debate what they would do with an extra £1000 to ensure we had adequate footage. Examples of what participants would use the money for include buying a kitten, paying off credit card debt, and a holiday to Croatia (all ideas from couples), investing in a coffee cart business, a very used car to fix up, and tickets to the rugby world cup (all from strangers).

Data Treatment

After data collection was complete, the recordings were initially processed in Vicon Nexus to label each marker (see Figure 14), remove surplus reflections, and remove gaps in marker trajectories. This generally occurs when a marker becomes occluded from two or more cameras before reappearing. Gaps were generally pattern filled by copying the trajectory of a marker on the same segment (e.g. a front wrist marker was pattern filled using trajectory data from the second wrist marker, as their relative positions never change). Gaps of more than 60 frames were not filled in order to keep the accuracy of the movement.

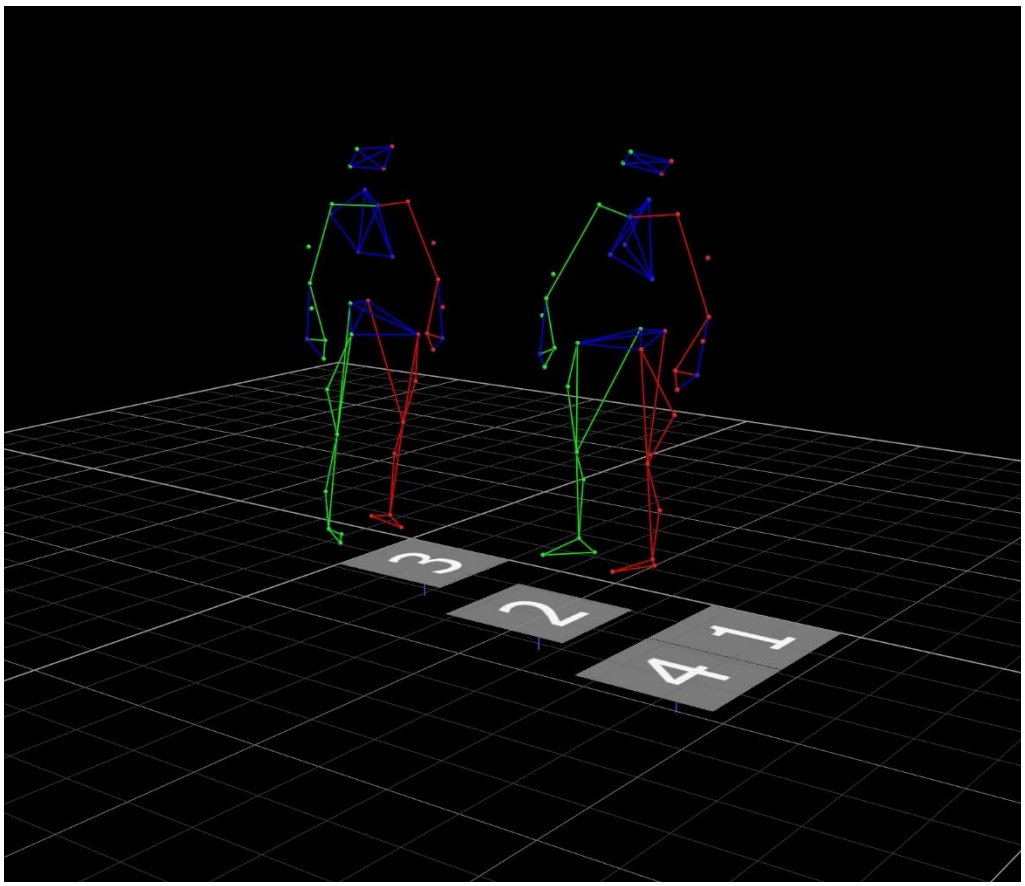

Figure 14: The initial stage of data work-up in Vicon

Once all gaps were addressed, the recordings were exported to Autodesk MotionBuilder 2017 to create standardised models for each participant. As markers are placed directly onto participants, this inherently does not control for structural body information such as height and build. We used MotionBuilder to create genderless, featureless humanoid figures, fitted to the movements of each participant. Gaps that could not be filled in Vicon (those over 60 frames) were fixed in MotionBuilder, by defining a 'rigid body' based on two or more markers to maintain the shape of markers in larger data gaps. Animating an avatar is a two-stage process. The first step involves fitting the optical marker data to a morphable 'actor' replicating the exact size and pose each participant stood in their T-poses (see Figure 15).

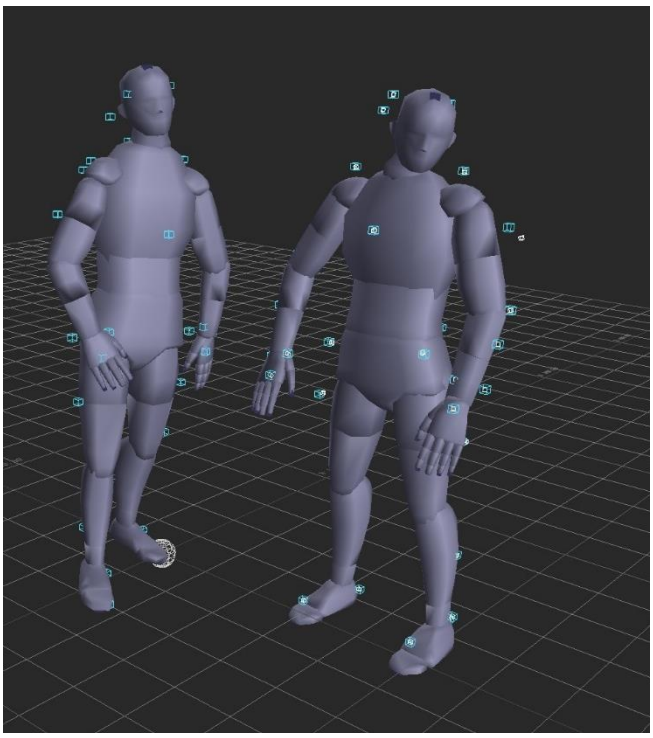

Figure 15: The first stage of Motion Builder, fitting an actor.

The second stage is to apply a featureless avatar to be driven by the actor. MotionBuilder does not natively recognise the layouts of the marker sets, and so we created a labelling template that defines which markers drive each part of the body (see Table 14).

Table 14: Markers grouped by body segment

Model Body Segment	Marker
Head	LFHD (left front head) LBHD (left back head) RFHD (right front head) RBHD (right back head)
Shoulders	LSHO (left shoulder) RSHO (right shoulder)
Upper Arms	LUPA (left upper arm) LELB (left elbow) RUPA (right upper arm) RELB (right elbow)
Forearms	LFRM (left forearm) LWRA (left inside wrist) LWRB (left outside wrist) RFRM (right forearm) RWRA (right inside wrist) RWRB (right outside wrist)
Hands	LFIN (left finger) RFIN (right finger)
Upper Body	C7 (upper back) CLAV (clavicle) STRN (sternum)

	T10 (lower back) RBAK (upper right back)
Waist/Hip	LASI (left front hip) LPSI (left back hip) RASI (right front hip) RPSI (right back hip)
Upper Legs	LTHI (left thigh) LKNE (left knee) RTHI (right thigh) RKNE (right knee)
Lower Legs	LTIB (left tibia) RTIB (right tibia)
Feet	LHEE (left heel) LANK (left ankle) LTOE (left toe) RHEE (right heel) RANK (right ankle) RTOE (right toe)

Once the model was complete, all trials were checked to ensure smooth motion, free of any artefacts. Finally, all trials were rendered into .AVI format, with no compression in a 1900x1080 pixel window. Seconds 30-60 were selected to be viewed by participants, as the first 30 seconds often participants were still getting used to the markers, and the final part participants were often directing their final decisions to the researcher off camera. Videos were then hosted on YouTube (see Figure 16).

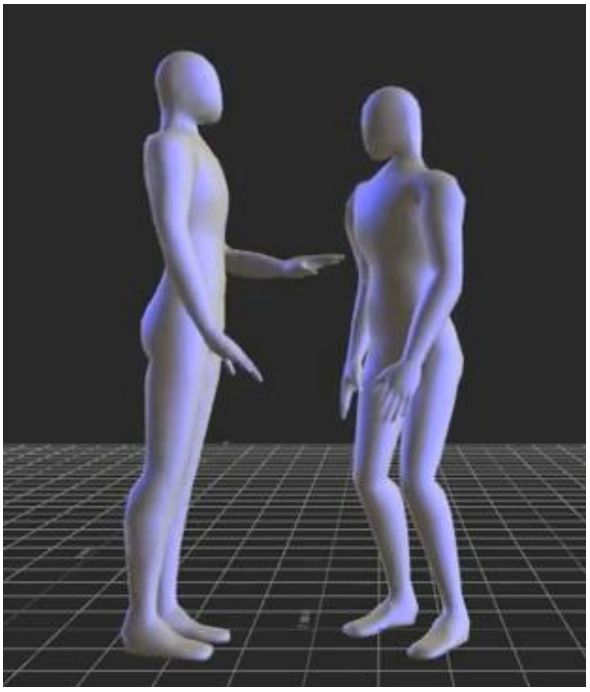

Figure 16: The final models

Ratings

17 participants (6 males) were recruited through opportunity sampling using Qualtrics (www.qualtrics.com). Participants were aged between 18-51 (M = 31.41, SD = 10.63). Participants watched the 30 second clips of each of the 20 pairs, and were asked to rate how similar each pair's body movement was on a scale of 1-7 (where 7 is extremely similar), asked if they believed the pair to be romantically involved or strangers, and asked to state why they thought that in a free text format.

Results

Raters correctly guessed which category each pair fitted into on average 12.53 times out of 20 (SD = 2.35, range from 9-17). Participants were slightly better at guessing strangers (M correct = 6.35, SD = 1.77, range = 4-9/10) than couples (M correct = 6.18, SD = 1.42, range = 4-9), but this was not significant (t (16) = 0.33, p = 0.74).

The similarity ratings for each couple was on average 4.66/7 (SD = 0.67, range 3.5- 6), with strangers (M =3.96/7, SD = 0.58, range 3.10-5.10) rated significantly less similar: $t(16) = 4.69$, $p < .001$, $d = 1.13$, 95% CI [0.51, 1.73], see Figure 17. There was no significant correlation between perceived similarity and couple satisfaction score: r_s = 0.263, p = 0.261, 95% CI [-0.216, 0.686]

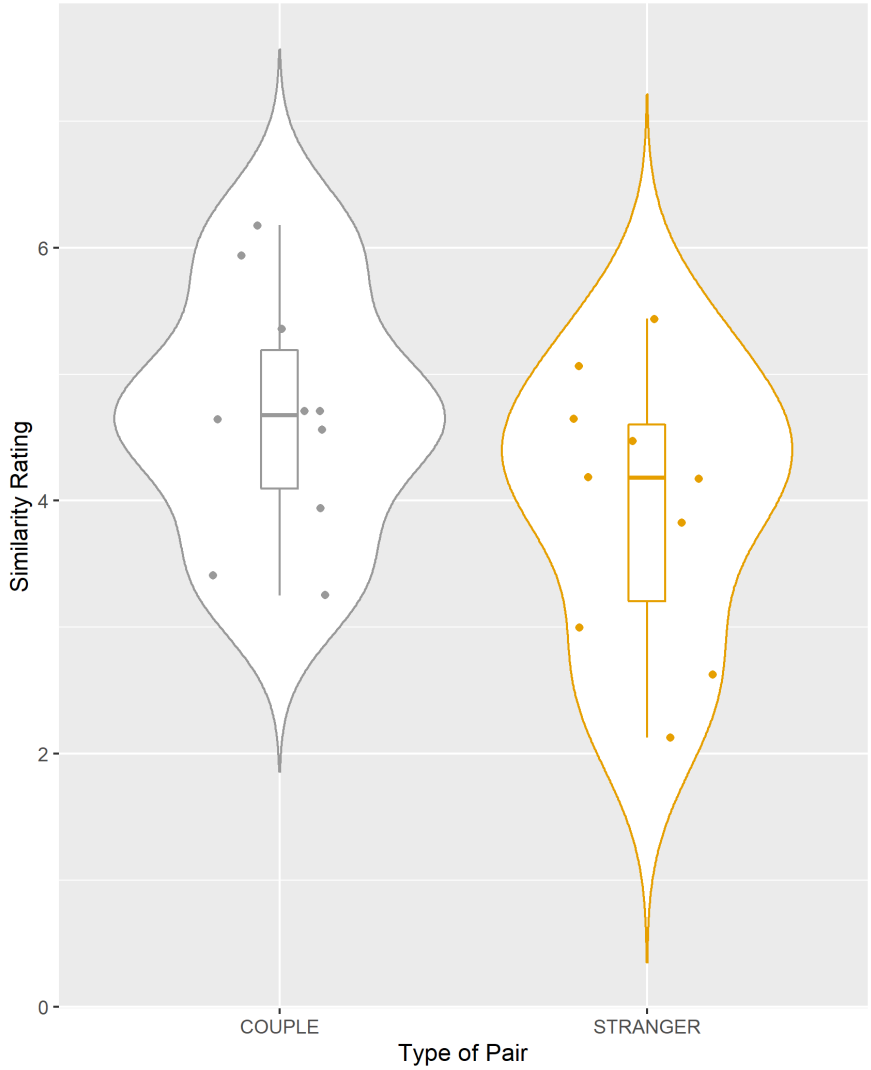

Figure 17: Similarity ratings by type of pair

Word clouds were generated in R using the wordcloud package (Fellows, 2018) for all of the free text answers where participants explained their decision, split by couple or stranger. Note that only participants who were correct had their text responses included in the word cloud. Common stop words (words which tend to be the most common in a language, usually function words) were removed from the data, e.g. we, I, you, they, and, as well as custom stop words which bore no relevance to the question, but were not classified as standard stop words. These stop words were: look, seem, seems, person, like, quite, looks, looked, one, body, and language.

Figure 18: Couple word cloud: size of word equates to the frequency of said word

The most commonly used words to describe couples related to proximity, and mentioned words such as comfortable, mirroring, and similar (See Figure 18 and Table 15).

Table 15: Top 20 most commonly used words to describe couples

Word	Frequency
Close	50
Together	24
Relaxed	12
Proximity	11
Gestures	10
Similar	10
Lots	9
Comfortable	9
Standing	8
Movement	8
Towards	8
Leaning	8
Mirroring	8
Movements	7
Open	7
Space	7
Another	7
Familiar	6
Hands	6
Closer	5

Figure 19: Word cloud for strangers: size of word equates to frequency of word

Again, participants used words to describe proximity, but this time in terms of distance rather than closeness (See Figure 19 and Table 16).

Table 16: Frequency table of top 20 words used to describe strangers

Word	Frequency
Apart	22
Far	17
Standing	15
Distance	15
Movement	10
Comfortable	10
Away	8
Stood	8
Much	7
Gestures	7
Awkward	7
Little	6
Interaction	6
Face	6
Hands	5
Limited	5
Another	5
Suggests	5
Movements	5
Gesturing	5

Finally, we created a comparison cloud to see the differences in descriptions of couples compared to strangers (See Figure 20).


close
together
apart
far
distance
proximity
relaxed
similar
mirroring
towards
lots
space
leaning
familiar
closeness
interaction
gesturing
standing
suggests
awkward
theyre
nervous
dominant
romantically
standoffish
mirrored
open
bothered
forward
closer
others
distant
limited
confident
something
suggesting
movements
argument
personal
languagemoving
eye
couple
made
leaving
within
rights
individual
similarity
heads
repetition
relationship
laughing
head
comfort
likely
suggesting
edging
hands
back
constantly
keeps
better
contact
small
ease
start
pointing
tough
lean
guard
inside
parts
touchingthey
postures
comfortable
understanding
suggest
situation
expressive
werent
talking
tilting
share
now
row
gesticulations
flirtatious
experienced
mirrir
participants
secret
neither
imagine
especially
although
plenty
softer
reciprocated
listening
may
presence
maybe
placements
timeslooks
somethinglike
today
positions
touching
buttons
acting
definitely
press
way
clos
persons
just
expansive
apparent
dont
two
raised
hand
almost
another
turn
argument
characters
agreeing
gestures
know
mirror
faily
practically
reaching
crossed
reason
first
gets
feel
relative
expect
mimicary
indepth
touch
period
negotiate
gap
high
friendly
behaviour
appears
gestures
moving
instruction
looking
opposite
posture
strangers
pushing
movement
virtually
physical
people
opinion
general
slightly
gesture
whilst
confrontational
time
stiff
overly
arms
equal
anything
blocked
verbal
boundaries
understood
chargethe
opened
major
partnership
unknown
unfriendly
unfamiliar
need
toward
guess
pacify
sureleft
making
frustration
bending
make
blocking
facing
cant
authoritative
behaviours
crosses
company
uses
firmespecially
pair
gestureshand
reassurance
rigid
familiarity
orderliness
legs
selfsoothing
subdued
wide
submissive
superman
uncomfortableunfamiliar
telling
sure
tentative
trying
doesnt
defensivewouldnt
shuffling
honest
turns
portion
armhands
avoid
don't
reserved
lot
timid
bit
stay
awkwardright
tense
reaction
feeling
video
turning
doesnt
exchange
defensive
shifting
awkwardness
someone
involved
also
feels
stance
angle
different
ish
standing
hip
due
ion
character
felt
figure
much
keeping
otherit
uncomfortable
cueslooks
humour
enough
person's
taken
promote
well
think
leg
still
really
handsdoesnt
ans
show
big
hips
use
try
little
less
arm
fun
etc
rely
explain
directly
used
neutral
soothing
waiting
completely
kept
actions
romantic
dominate
languagebody
guarded
pose
move
direct
though
animated
movementsdoesnt
standaround
limitednot
legged
distanced
take
face
appear
significant
static
stood
isnt
might
away
distancequite
moment
copying
flirty
second
conversation
initially
behind
disinterested
turned
repeatition
partner
pointing
keeps
better
constantly
edging
space
lots
areas
similar
towards
familiar
closeness
personal
languagemoving
couple
eye
made
leaving
within
rights
individual
similarity
heads
repetition
relationship
laughing
head
comfort
likely
suggesting
day
mirroring
proximity
open
mirrored
confident
bothered
forward
closer
others
distant
limited
leg
still
really
think
uncomfortable
cueslooks
humour
enough
person's
taken
promote
well
mimicary
expect
relative
indepth
touch
period
negotiate
gap
high
friendly
behaviour
appears
gestures
moving
instruction
looking
opposite
posture
strangers
pushing
movement
virtually
physical
people
opinion
general
slightly
gesture
whilst
confrontational
time
stiff
overly
arms
equal
anything
blocked
verbal
boundaries
understood
chargethe
opened
major
partnership
unknown
unfriendly
unfamiliar
need
toward
guess
pacify
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making
frustration
bending
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orderliness
legs
selfsoothing
subdued
wide
submissive
superman
uncomfortableunfamiliar
telling
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trying
doesnt
defensivewouldnt
shuffling
honest
turns
portion
armhands
avoid
don't
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couples and 10 pairs strangers, to decide if the pair was a couple or strangers, and why they thought that.

We found that couples' interactive movements were rated as significantly more similar than strangers, and that participants were slightly better at identifying strangers, though not significantly so. Participants more frequently mentioned mirroring/similarity terms when describing couples than strangers, although proximity was a key factor in both: distance with strangers, closeness with couples. Our data fits with the literature surrounding assortative mating: previous work has found that couples are similar heights, attractiveness levels, have similar humour styles, and education levels, among other traits. Now we add to the literature, showing that couples are also perceived to be similar in movement, although the main driving factor behind correct decisions were made based on proximity. While we find that mimicry is present in couples more than in strangers, this chapter has brought about more questions than it answers, resulting in the decision to use this data as a pilot for future research.

This study revealed that participants took into account the distance between avatars when making a decision about the relationship status. We considered keeping participants at a specified distance during the recording of the videos; however, we were concerned that this would reduce the natural behaviour of participants. Taking this study forward, we will edit all of the avatars to be the same distance apart, in order to see if participants can still identify couples from strangers without a proximity cue.

Due to the advanced nature of the motion capture data, we intend to analyse the biomechanical data collected during this study for a future research avenue. Using biomechanical data can help us to identify objectively the differences between couples and strangers, rather than simply perceived differences. For example, using biomechanical data can show if the angles of arm movements are mirrored objectively, compared to perceptions of general mirroring from participants' free text responses. In addition, we can use timings: are participants mirroring each other with a delay or simultaneously?

In addition, to further add to the qualitative aspect of this study, we will conduct a thematic analysis on the free text responses in order to add more detail as to what exactly made participants select partner or stranger.

Finally, collecting personality measures may be enlightening in this type of research: for example, one very dominant personality type may communicate with their bodies differently to a very submissive person, and this could be interesting to take into account, particularly when analysing strangers' body language.

Chapter 5: Isn't it eyeronic? Little evidence for consistent eye colour choices across relationships[1]

Introduction

So tell me what you want, what you really, really want

Spice Girls, Rowe & Stannard (1995)

The freedom to choose a romantic partner is big business. In modern Western societies, people expect more control and choice over their dating lives than in many other historical and contemporary societies. Traditionally, constraints around individual partner choice arise from cultural practices such as prohibitions on divorce or non-heterosexual couplings, and arranged marriages (Apostolou, 2007, 2014; Buunk, Park, & Dubbs, 2008). In contrast, recent technological innovations mean that people in many societies have easy access to a large number of potential partners (Blackhart, Fitzpatrick, & Williamson, 2014; Gatter & Hodkinson, 2016); the dating app Tinder creates one million dates per week in 190+ countries, and is estimated to have around 50 million total users and 10 million daily users (Tinder, n.d.). Speed-dating, where individuals encounter a room full of dating options (usually between 10-30 singles), who each get 3-7 minutes to make an impression, is another feature of contemporary life that increases access to a number of potential dates in one evening (Stulp, Buunk, Kurzban, & Verhulst, 2013). Such methods allow people to meet others in greater numbers than people previously relied upon more exclusively, such as placing personal ads in newspapers or frequenting nightclubs (Kendall, 2011).

Furthermore, changes in societal trends mean that people are able to leave long-term relationships such as marriage more readily in order to re-enter and enlarge the dating market (Chiappori & Weiss, 2006). All of these dating trends and innovations, in many

[1] This chapter is currently under review at Archives of Sexual Behaviour (as of 18/09/2019)

contemporary western societies, imply that people value choice in relationship formation, and have a set of preferences that they will attempt to fulfil in selecting a partner.

The drive to realise our preferences in a romantic partner assumes that what we want is both individually-specific and reasonably stable. Although the stability of partner preferences has received surprisingly scant attention, there is plenty of evidence for individually-specific preferences. Sexual orientation is the most obvious example of individually-specific preferences, but we also see preferences for more idiosyncratic individual differences. For example, the matching hypothesis states that men and women of similar levels of attractiveness are drawn to each other, so that beautiful women and handsome men will end up romantically paired (Feingold, 1988; Jones et al., 2008; Lee et al., 2008). Similarly, real-life married couples tend to be highly matched for age and religiosity (Watson et al., 2004) and height (Stulp et al., 2017), see Chapter 1 for more details.

Regarding specific physical traits, an area where we might predict individually-specific, stable, consistent preferences is that of partner eye colour. People tend to pick partners who demonstrate some resemblance to their parents (Valentova, Varella, Bártová, Štěrbová, & Dixson, 2017; Bereczkei, Gyuris, Koves, & Bernath, 2002; Bereczkei, Gyuris, & Weisfeld, 2004; Marcinkowska & Rantala, 2012; Wiszewska, Pawlowski, & Boothroyd, 2007), and several studies have reported that a person's stated ideal partner hair and eye colour correspond to that of their parents (Little, Penton-Voak, Burt, & Perrett, 2003; Wilson & Barrett, 1987; Saxton, 2016). Furthermore, many dating websites include the ability to state both one's preferences for, and one's own variety of, physical attributes such as hair colour and eye colour, suggesting that such traits are considered important to individuals in the dating market.

Two studies have researched the stability of actualised mate choices over multiple relationships (Eastwick, Harden, Shukusky, Morgan, & Joel, 2017; Štěrbová, Tureček, & Kleisner, 2018). In the former, one hundred and thirty-six university students provided useable photographs of at least two current/former opposite-sex partners. Research assistants rated each photo on a range of physical attributes. The authors found similar

levels of attractiveness, masculinity, and dominance across a participant's current/former partners. This finding was irrespective of whether the relationship was serious or casual (as defined by the participant who selected one of four pre-defined descriptions of the relationship). In the latter, 1,048 participants provided data regarding their previous partners' eye and hair colour via an online study. The authors found significant consistency with respect to hair and eye colour of partners in both long-term (LT) and short-term (ST) partners, with small effect sizes. The authors concluded that individuals, therefore, have a type. However, this study made use of self-reported data, which could have increased the likelihood of false positives if, for example, participants had any sort of bias towards mis-remembering previous partners as being more similar in colouration than they were. Further, the study did not take account of ethnicity, meaning that an apparent preference for consistency in partner colouration could be an outcome of a tendency for people to select partners of similar ethnic grouping (McClintock, 2010).

Aims

People have individually-specific partner preferences, and we have both evidential and theoretical reasons to believe that an individual's partners should exhibit similarities in physical traits such as eye colour, particularly in contexts where people have ostensibly a great deal of freedom to choose their romantic partner. Accordingly, we address the extent to which people realise their preferences across different partners. Specifically, we investigate whether we can replicate findings of consistency in the eye colour of an individual's romantic partners, which cannot be explained as recollection bias or as a simple outcome of ethnic group matching in partnership formation. In order to consider people from a range of age categories, we sample across a student-centred population, an adult population (aged 30-55), and to combat memory deficiencies, we also use a set of well-known celebrities, whose partner eye colours can be identified by the researchers.

Methods

The research received ethical approval from the Department of Psychology Ethics Committee at the authors' institution before data collection commenced.

Participants

Student-centred sample.

186 participants (40 males) were recruited through opportunity sampling using social media and on campus at an English university. Although we did not set out to recruit students explicitly, it is likely that the majority of the participants were students given how the study was advertised. Our goal was to recruit at least 120 participants within the three-month testing period. Participants had to be aged 18 or over and to have had at least two romantic partners. Participants were aged 18–55 years old (M = 23 years, SD = 7 years), and participants reported having between 2 and 21 partners (M = 4, SD = 3.31), with a total of 392 ST and 352 LT recorded. The majority of the sample identified as heterosexual (87.1%; homosexual= 2.7%, bisexual= 8.1%, other= 1.6%). While there were no sampling restrictions with regard to ethnicity, the sample was overwhelmingly White: 91.9% White, 2.7% mixed race, 2.7% Asian, 1.6% Black, and < 1% other.

30-55 years old sample.

Because the student-centred sample was predominantly younger people (only 25 participants over 30 years old), 208 participants (75 males) aged 30 – 55 were recruited separately. This is important as one could predict that type preferences might not be fully apparent from a younger sample who provide fewer data points (previous partners) given their time spent in the dating market. The 30-55 years old sample was recruited via opportunity sampling through social media (n = 58), and the use of a recruitment website (www.prolific.ac) (n = 150). Although it is not possible to confirm where online participants are sampled from, Prolific recruits participants from within the UK, and the social media sites were targeted to a UK audience. Our sample size goal was to match or exceed the number of participants in the student sample. Participants from Prolific were reimbursed £1.25 upon completion of the questionnaire. Participants had to have had at least two

romantic partners and be aged between 30-55, managed by having filter questions on Prolific. Ages ranged between 30-55 years old (M = 40 years, SD = 7 years), and participants reported between 2 and 21 partners (*M*= 6.75, *SD*= 4.27). 801 ST and 619 LT were recorded. The majority of the sample identified as heterosexual (86.5%, homosexual= 4.3%, bisexual= 8.7%). As in study 1, there were no sampling restrictions in terms of ethnicity. The sample was predominantly White (95.6%; <1% mixed race, <1% Asian, 1.96% other).

Celebrity Sample.

We chose a celebrity sample as a useful comparison group because we hypothesised that celebrities are typically considered very desirable partners, with access to many dating pools, and so might be freer to realise their physical preferences than other groups. Partner information relating to 185 celebrities (96 males) was obtained from online information sources. Some celebrities (actors/musicians) were taken from the IMDB top 100 actors (those with partner information available), and then snowballed from there to related actors, for example, biological relatives who were famous, or cast mates. Interrater reliability for celebrity (and partner/parent) eye colour selection was κ = .480, p < .001 for all eye colours, and κ = .847, p < .001 when split by light and dark, resulting in moderate to excellent agreement between two raters.

Our sample size target was to match the student-centred sample at a minimum. All participants were over 18 years old and had to have had at least two romantic partners. Partners were researched and included only if there was confirmation from the celebrity they were romantically involved. Participant ages ranged from 20- 65 (M = 38 years, SD = 8 years) and had between 2 and 26 (M= 5.87, SD= 4.12) confirmed partners. 378 ST and 708 LT were recorded. Differentiation between LT and ST partners were made based on whether the couple had publicly been together for over six months. The vast majority of the sample were heterosexual (97.3%, bisexual= 2.7%). All celebrities were of White ethnic origin.

Materials and Procedure

Participants from the student-centred and the 30 – 55 sample were directed to a questionnaire hosted by Qualtrics (www.qualtrics.com), and confirmed that they had had two or more partners (current/previous) in their lifetime. Eligible participants provided their age, gender, and sexual orientation, and were then asked to list all of their sexual/romantic partners in chronological order since the age of 16. For each partner, the participants listed their gender, ethnicity, eye colour (black, dark brown, light brown, hazel, green, blue-green, blue, grey, Little et al., 2003), a rating on a 1-5 scale of the participant's confidence in their correct recollection of the eye colour (where 1 is complete guess, 5 is absolutely certain), and a relationship category (ST or LT). Participants were told that ST were casual encounters- one-night stands, friends with benefits etc., while LT were defined as committed relationships. Both samples stated that their confidence in correctly recalling the eye colour of each partner ranged from 1-5 (student sample: M= 4.17, SD= 0.68; 30-55 sample: M= 4.15, SD= 0.72). Both samples significantly deviated from the mid-point of the scale (3) in a positive manner (student sample, $t(184) = 21.514$, $p < .001$; 30-55 sample, $t(208) = 21.695$, $p < .001$). To obtain partner eye colour information about the celebrities, the lead author consulted well-lit photographs published on fan websites and interviews with celebrities and noted the eye colour of confirmed romantic partners.

Results

Data Analysis Strategy

All analyses were carried out in R (R Development Core Team., 2008). First, we created simulated permutations of the dataset. Each permutation was a version of the dataset where the data points, namely the partner eye colours, were randomly transposed. In the simulations, each participant retained the same number of partners (so a participant who listed the eye colours of three partners would still be listed next to the eye colours of three partners), and the total quantity of each eye colour remained the same (so if there were 500 blue-eyed partners listed in the original dataset, there would

also be 500 blue-eyed partners listed in each simulated dataset). We created 100,000 such simulated datasets. Then, for each participant in every dataset, we calculated the proportion of partners whose eye colour was in the majority for that participant. Thus, a participant listed next to four partners (three blue-eyed and one brown-eyed), would have a score of .75; a participant who reported four partners (two blue-eyed and two brown-eyed), would have a score of .5. Finally, we used a paired-samples *t*-test to compare the proportion of matches in the real dataset to each of the 100,000 simulated datasets. The use of simulated datasets means that we overcome the potential problem that the frequency of colours in the sample might vary (e.g. there might be a majority of brown-eyed people), which would give rise to illusions of systematic partner preferences, when in fact consistency of eye colour choice across partners could arise simply from a higher prevalence of one colour type. As we had a directional hypothesis, we employ one-tailed testing. We report the median significance level and effect size using Cohen's *d* following Westfall (2016). We also analysed LT and ST separately, following the same strategy. We ran the analyses both using the original eye colour terms, and then separately following categorisation of the eye colours into light (blue, blue/green, grey, green) or dark (black, dark brown, light brown, hazel) following Little et al., (2003), and also to overcome problems of colour categorisation (e.g. one person's brown might be another's hazel). The code and data are available on the OSF: **https://osf.io/fstv9/?view_only=b4ffccf580044c74be8c6739977e8882.**

Analysis

Table 17 shows the results of the analyses performed, split by sample and the way eye colour was operationalised. Following Stulp, Buunk, Pollet, Nettle, & Verhulst (2013), we present the median *p*-value (one-tailed), median effect size, and the percentage of permutations where the original dataset had a significantly higher proportion of matches. Some evidence for consistent eye colour preferences across romantic relationships came from the student sample when eye colours were categorised into dark or light. However, when ST and LT were considered separately, it became clear that this effect was driven by the LT data. Other evidence for consistent eye colour preferences across

sequential romantic relationships came from the 30-55-year-old sample, when all eye colours were considered (instead of being categorised into dark vs light), in relation to LT only. However, when we excluded all participants who did not categorise themselves as White, only the effects from the 30-55-year-old sample were statistically significant.

*Table 17: Median p values and Cohen's d. * = p < .05*

Sample	Eye colour categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% CIs]	% significant (*p*<.05, one-tailed)
Student	All colours	All relationships	*p* = 0.08, [0.01, 0.42]	*d* = 0.13, [0.02, 0.24]	36%
		Short-term (392)	*p* = 0.18, [0.01, 0.64]	*d* = 0.06, [0.01, 0.14]	13%
		Long-term (352)	*p* = 0.06, [0.01, 0.37]	*d* = 0.11, [0.03, 0.20]	44%
	Dark/Light	All relationships	*p* = 0.03, [0.01, 0.33]*	*d* = 0.17, [0.04, 0.31]	60%
		Short-term	*p* = 0.45, [0.06, 0.90]	*d* = 0.06, [0.01, 0.14]	2%
		Long-term	*p* = 0.04, [0.01, 0.32]*	*d* = 0.17, [0.04, 0.29]	59%
30-55 years old	All colours	All relationships	*p* = 0.05, [0.01, 0.31]	*d* = 0.14, [0.04, 0.23]	47%
		Short-term (801)	*p* = 0.11, [0.01, 0.49]	*d* = 0.08, [0.01, 0.16]	24%
		Long-term (619)	*p* = 0.01, [0.01, 0.14]*	*d* = 0.18, [0.09, 0.27]	85%
	Dark/Light	All relationships	*p* = 0.20, [0.02, 0.68]	*d* = 0.08, [0.01, 0.20]	11%
		Short-term	*p* = 0.18, [0.01, 0.65]	*d* = 0.08, [0.01, 0.19]	14%
		Long-term	*p* = 0.09, [0.01, 0.52]	*d* = 0.12, [0.01, 0.24]	32%
Celebrity	All colours	All relationships	*p* = 0.28, [0.05, 0.68]	*d* = 0.06, [0.01, 0.16]	2%
		Short-term (378)	*p* = 0.08, [0.01, 0.44]	*d* = 0.10, [0.02, 0.18]	34%
		Long-term (708)	*p* = 0.37, [0.06, 0.82]	*d* = 0.04, [0.01, 0.13]	2%
	Dark/Light	All relationships	*p* = 0.27, [0.03, 0.75]	*d* = 0.07, [0.01, 0.19]	6%
		Short-term	*p* = 0.32, [0.03, 0.83]	*d* = 0.05, [0.01, 0.16]	5%
		Long-term	*p* = 0.39, [0.05, 0.86]	*d* = 0.05, [0.01, 0.16]	3%

The effect sizes for all analyses were minimal, with the median effect size falling below 0.2, classified as a small effect (Cohen, 1977). Figure 21 and Figure 22 illustrate the distribution of effect size.

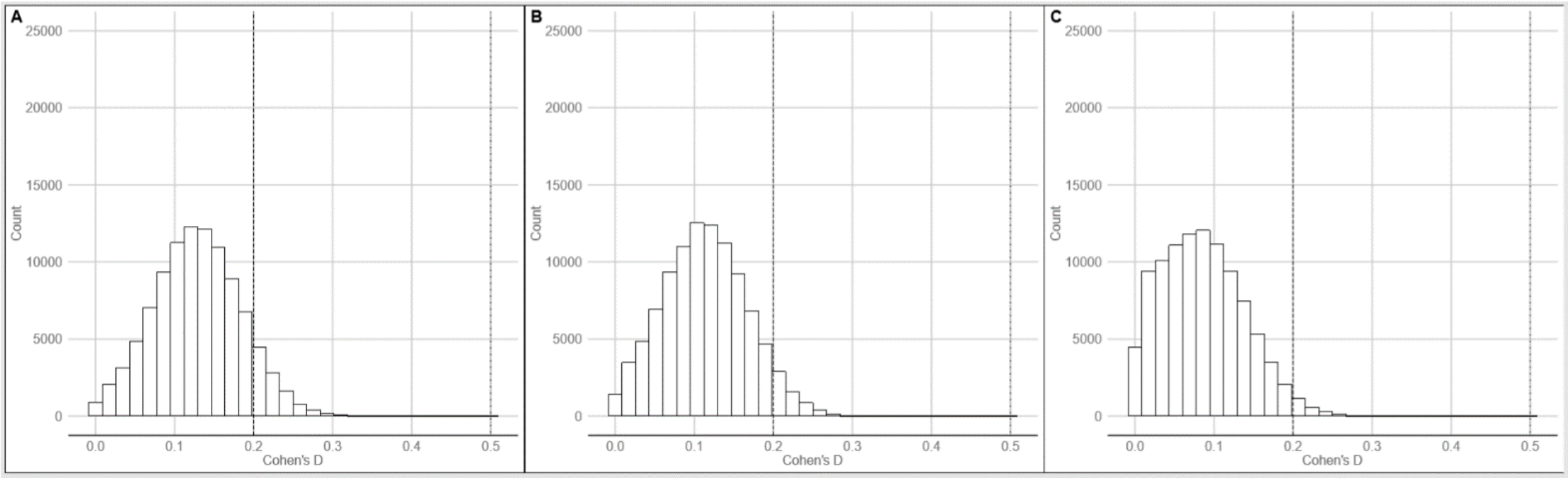

Figure 21: Cohen's d distributions for analyses categorising colour into all colours (A: Student-centred, B: 30-55 year old, C: Celebrity) 0.2 Reference line for small effect

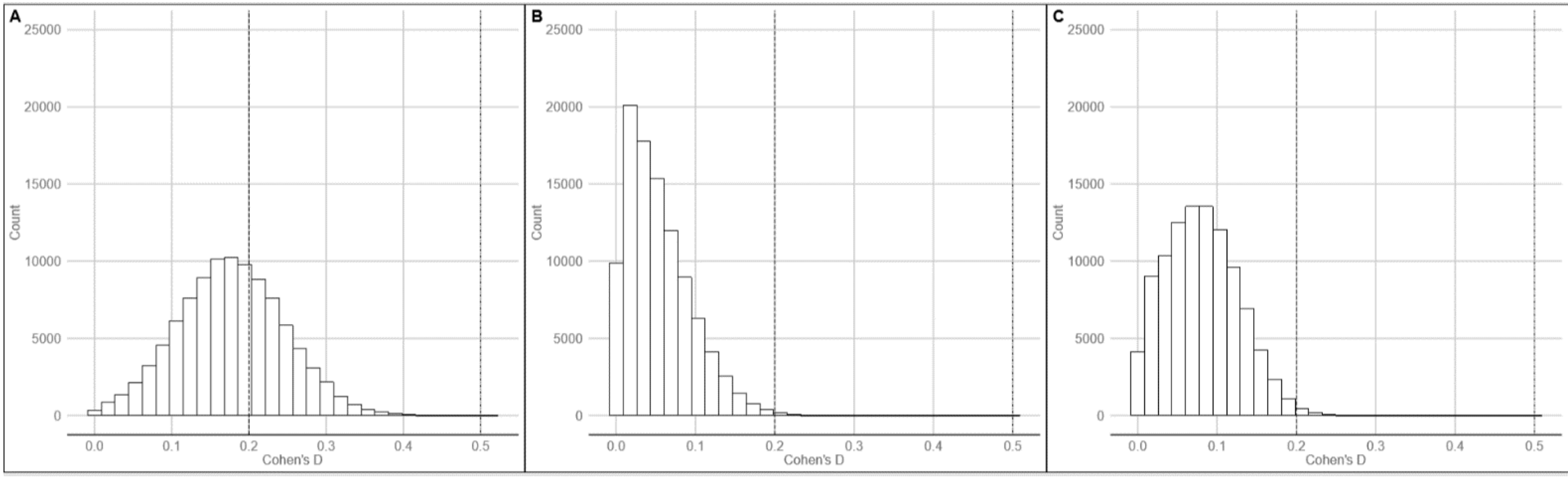

Figure 22: Cohen's d distributions for analyses categorising colour into dark and light (A: Student-centred, B: 30-55 year old, C: Celebrity) 0.2 Reference line for small effect

Discussion

Popular culture leads us to believe that individuals have a type, a preference for certain physical characteristics that is apparent across their relationship history. Indeed, as set out in the Introduction, there are good theoretical reasons to believe that this will be the case. Accordingly, we set out to investigate whether preferences for physical characteristics (specifically, eye colour) are evident across an individual's relationship history as found in Štěrbová et al., (2018).

We found only very weak evidence for consistent eye colour preferences. Some evidence arose from the student-centred sample when their partners' eye colours were classified into dark vs light. Here, consistency in eye colour preference was apparent when all of the relationships were considered together, although the separation of the data into ST and LT showed that this finding was driven by eye colour consistency across LT but not ST. That is, among the students, there were slightly more people who had higher proportions of dark-eyed partners or higher proportions of light-eyed partners, then would be expected by chance. However, when the analysis considered only White participants, the effect was no longer apparent. Human eye colour is remarkably diverse in northern and eastern Europe, with less variability as one moves outward (Frost, 2006), and as cultural homophily is still evident (McClintock, 2010), the apparent findings of weak consistent eye colour preferences could be explained by cultural homophily.

Other evidence for preference consistency arose from the analysis of the LT relationship history of the 30-55 years old sample, when the complete range of eye colours was considered (instead of being collapsed into dark vs light). That is, people showed more consistency in terms of the reported eye colours of their partners than would be expected by chance. This effect was still apparent when we restricted our sample to participants who categorised themselves as White.

Our celebrity sample did not provide any evidence for consistency in eye colour across multiple relationships. We predicted that celebrities should be better placed than the

other groups to realise their partner aspirations, and in addition, our celebrity sample did not suffer from the potential recollection biases that could create false positives in our other samples. Accordingly, our overall pattern of results does not give us any particular confidence that there is good evidence for strongly consistent eye colour preferences across multiple relationships. However, it should be noted that we could only include partners who had been mentioned in the media, there are sure to be more partners of celebrities we do not know about, and this may influence the results.

The data imply that eye colour is not a priority in relationship initiation. Indeed, individuals' idealised preferences for eye colour might be less apparent from a dataset of actual relationships, in which people may not be able to realise all of their partner preferences. This is perhaps in part because relationship formation is a mutual decision, at least in WEIRD populations (Baldauf, Kullmann, Schroth, Thünken, & Bakker, 2009), and time constraints may mean that people settle for less than perfect partner attributes (Cotton, Small, & Pomiankowski, 2006). The existence of a partner who matches your preferences, and is available in the face of potential competition from other individuals, means that very few people will be able to obtain a partner who fulfils all of their ideal preferences (Conroy-Beam & Buss, 2016). Some evidence suggests that individuals are more likely to lower their requirements in ST contexts (Kenrick, Groth, Trost, & Sadalla, 1993; Kenrick, Sadalla, Groth, & Trost, 1990; Li & Kenrick, 2006; Stewart, Stinnett, & Rosenfeld, 2000). In a one-night stand or similar for example, the preference for a certain eye colour could be one of the characteristics we are willing to compromise on. Indeed, our limited evidence for any sort of eye colour consistency was more apparent in LT than ST.

At first, it may appear that our study contradicts Štěrbová et al., (2018), however, we believe that when recollection bias, ethnicity controls, and small effect sizes are taken into account, we present a similar result. Our celebrity sample was not hampered with recollection bias and found no evidence for eye colour consistency choices across partners. Our analysis that restricted the sample to White participants lost the few effects we had found in the previous analysis, suggesting that using a multi-ethnic sample could

result in the appearance of consistency, but is actually linked with racial homophily. Finally, both papers find very small effect sizes, suggesting little real-world significance.

Our data present an apparent paradox. Previous research has indicated that people's parents and partners have similar eye colour, which would indicate that people should be more likely to couple up with partners who have similar eye colour across multiple relationships, but our data do not point to this as a reliable effect. To resolve this paradox, we might suggest that individuals' preferences for eye colour are most apparent in the relationships most likely to have been captured in previous studies, which are those ones that last the longest amount of time, and are thus more likely to be picked up in cross-sectional sampling. There is some limited support for this point in that our results were clearest in relation to the LT rather than ST.

As with all self-report measures, we rely on the ability of two of our sample groups to accurately recall their previous partners' eye colours. Participants reported being relatively confident in their answers, and previous research that asked students to state their parents' hair and eye colours, and then subsequently to contact their parents to ask for the parents' own description of their hair and eye colour, found a high degree of consistency between the two sets of reports (Saxton, 2016). Future studies could circumvent this issue by using photographs of previous partners. Additionally, knowing where participants lived could be of use to analysis, as place of residence could limit partner choice (e.g., Štěrbová, Tureček, & Kleisner, 2019).

Chapter 6: Daddy's boys and mummy's girls? Little evidence for opposite-sex parental imprinting on partner eye colour.

Introduction

Couples have been found to resemble each other. Positive assortment has been found in couples regarding their education level, religiosity, race, sense of humour, personality, height, and attractiveness, amongst others (Domingue, Fletcher, Conley, & Boardman, 2014; Ellison, Burdette, & Bradford Wilcox, 2010; Hahn & Campbell, 2016; Little, Burt, & Perrett, 2006; McClintock, 2010; Stulp, Simons, Grasman, & Pollet, 2017). Interestingly, people in relationships have also been found to look like their partner's parents, both biological and adoptive (e.g. Bereczkei, Gyuris, Koves, & Bernath, 2002; Bereczkei, Gyuris, & Weisfeld, 2004). Bereczkei's work showed that participants correctly matched wives to their mothers-in-law, and husbands to their fathers-in-law, suggesting male subjects married women similar to their mothers, and female subjects married men similar to their fathers. Children of mixed race parents tend to marry into the ethnic group of their opposite-sex parent (Jedlicka, 1980), and daughters of older fathers tend to marry older men (Zei et al., 1981). Additionally, the height of an individual's partner is positively correlated to the opposite-sex parent (Seki et al., 2012).

The similarities between parents and partners have also been noted in relation to traits that are more specific. Recently, Valentova, Bártová, Štěrbová, and Varella (2017) found that their sample of Czech and Brazilian men preferred a waist-to-hip-ratio similar to their mothers in childhood, with Czech men also preferring a similar breast size in their partners to their mothers. Similarly, a positive correlation was found between the degree of hairiness in a woman's partner and her father (Rantala et al., 2010). Particularly interesting is the finding that often individuals can recognise that they find traits attractive that are similar to their parents (Griffee et al., 2017). 19% of women and 16% of men

were aware that they were attracted to individuals resembling a family member, mainly their opposite-sex parents.

Eye colour similarities between partners and parents are a common find in the literature, both past and present. An early study found that teenage girls' boyfriends were more likely to have matching eyes with her father than her mother (Wilson & Barrett, 1987). It also appears that the partner-sex parent is the most commonly matched (Debruine, Jones, Little, & Debruine, 2017; Little, Penton-Voak, Burt, & Perrett, 2003), and that the quality of relationship between the offspring modulates the colour similarities, that is, the closer or more supportive the relationship, the more likely their partner is to have similar eyes (Bressan & Damian, 2018; Saxton, 2016).

There are multiple possible explanations for parental-partner similarity. Firstly, an imprinting-like mechanism, or social learning (Little et al., 2003), in which individuals make a template based on their parent to help select future mates (e.g. Bressan & Damian, 2018). Several studies have suggested self and/or parental-referential phenotyping, and using that phenotype to influence social behaviour in a positive or negative fashion (e.g. Debruine et al., 2017; Rantala & Marcinkowska, 2011). Another possible explanation is the mere exposure effect (Zajonc, 1968) - that is, familiar features are attractive. This theory would suggest that individuals pick partners based upon familiar features, which would fit with the literature surrounding eye colour matching, however, the findings suggest that the parent the same sex as the partner is more influential. If it was the mere-exposure effect, surely it would be the parent that spent the most time with the child? This was particularly evident in one study, where no significant effects of maternal eye matching were found (Bressan & Damian, 2018). Alternatively, parent-partner similarities could be inherited preferences. If the mother prefers blue eyes in a partner and marries a blue-eyed man, their child may inherit that preference for blue eyes. However, limited research with adopted children shows that there is still a visible similarity between partner and parent (Bereczkei et al., 2004), and thus may not be the

best explanation. Finally, it could be assortative mating in action (Marcinkowska & Rantala, 2012). Either way, there is plenty to be disentangled in this area of the literature.

One potential issue with the majority of past literature is the age of participants. As is the case with most psychology experiments, participants are often young students in their early twenties (e.g., Bressan & Damian, 2018; Debruine et al., 2017; Saxton, 2016). This could cause an issue when looking at parent-partner similarities, as participants this young may not have had adequate time in the dating market to realise their preference, or have not dated multiple people. Additionally, if the similarities are due to mere exposure, the fact that some young participants may still live with their parents could affect the preference. If so, it would be expected that the longer the time since living with their parent, the smaller the similarities would be. Finally, there is only one study to date investigating actualised preferences over time (Štěrbová et al., 2018). Without more longitudinal data looking at participants' lifetime relationships, the data we are left with is either current partner, which may not be representative of their general trend of partner choice, or ideal partner, which may not translate to actualised relationships. Moreover, such data would not show if a particularly bad break up could end the parent-partner similarity (I.e. a bad experience with a blue-eyed man could result in avoidance of blue-eyed men).

The one experiment that has examined similarities in parental eye colour to partners across a participant's dating life showed that a.) Participants consistently chose partners of a particular eye colour, in both long and short-term relationships, and b.) The eye colour of a partner was predicted by the eye colour of the opposite-sex parent (Štěrbová et al., 2018). However, this study made use of entirely self-reported data, which can suffer from recollection bias (e.g., my dad's eyes are blue, so mum's probably are too). This could increase the likelihood of a false positive if any bias did occur. Additionally, there was no account taken of ethnicity, but racial homophily is still evident today, and could over-represent the effect of imprinting (McClintock, 2010).

Aims

Chapter 5 found little evidence of consistent preferences partners, however did not take into account self or parental similarity which many studies focus on, in terms of ideal partner studies, but not whole dating life history. Accordingly, we examined the extent to which people's partners match their parents' eye colour and their own eye colour, across their whole dating life, controlling for recollection uncertainty and mixed ethnicity sampling,

Method

Participants

Student Sample

153 participants (32 males) were recruited through opportunity sampling using social media and undergraduate psychology students at an English university. Our goal was to recruit at least 120 participants within the 3-month testing period. Participants had to be aged 18 or over and to have had at least two romantic partners to test for stability of choice. Participants were aged 18–55 years old (M = 23, SD = 7 years), and participants reported having between 2 and 21 partners (M = 3.90, SD = 2.95). While there were no ethnicity requirements, the sample was overwhelmingly white: 91.9% white, 2.7% mixed race, 2.7% Asian, 1.6% black, and < 1% other.

30-55-year-old sample

Because the first sample was predominately younger people (only 25 participants over 30 years old), 170 older participants (60 males) were recruited through a mixture of opportunity sampling through social media, and the use of a recruitment website (www.prolific.ac) to investigate if eye colour preference remained stable as an individual matured. Participants from Prolific were reimbursed £1.25 upon completion of the questionnaire. Our goal was to match the younger sample regarding number. Participants had to have had at least two romantic partners, although for the Prolific sample we requested four or more partners to aid analyses. Ages ranged between 30-55 years old (M = 40, SD = 7), and participants reported between 2 and 21 partners (M

= 6.56, SD = 4.03). While there were no specific ethnicity restrictions, the sample was predominately white (95.6%, <1% mixed race, <1% Asian, 1.96% other).

Celebrity Sample

To counteract the issues of self-report bias and errors, we obtained partner and parent information relating to 133 celebrities (83 males) from online information sources. Some celebrities (actors/musicians) originated from IMDB top 100 actors (those with partner and parent information available), and then snowballed from there to related actors, both biologically and in terms of shared projects. Our goal was to match the previous samples at a minimum. All celebrities were over 18 years old and had to have had at least two romantic partners. Participants ranged from 21- 61 (M = 38, SD = 8 years) and had confirmed partners between 2 and 26 (M = 6.01, SD = 4.35). We categorised the relationships into 'short-term' if the couple had not yet been or did not stay together for at least 6 months, and 'long-term' if the couple stayed together for longer than 6 months. All celebrities were of white ethnic origin based on their physical appearance.

Materials and Procedure

A full description of the methods can be found in Chapter 5. Briefly, participants in the student sample and 30 – 55-year-old sample described the eye colour of each of their romantic partners, along with categorising them into long or short-term relationships. Eye colours were categorised into light (blue, blue/green, grey, green) and dark (black, dark brown, light brown, hazel) following Little et al., (2003), to avoid different perceptions of eye colours (e.g., one person's brown may be another's hazel), and to overcome for the difficulties of converting eye colour categories into scales. We also asked participants to list their eye colour and their parents' eye colours.

Each participant rated their confidence in the accuracy of their eye colour selections on a scale of 1-5 (where 1 is a complete guess, 5 is completely certain). Both samples stated that their confidence in correctly recalling the eye colour of each partner ranged from 1-5 (student-centred sample: M = 4.17, SD= 0.68; 30-55 year old sample: M = 4.15, SD=

0.72). Both samples significantly deviated from the mid-point of the scale (3) in a positive manner (student sample, $t(184) = 21.51$, $p < .01$; older sample, $t(208) = 21.70$, $p < .01$).

To obtain eye colour information about the celebrities, the lead author consulted well-lit photographs published on fan websites and interviews with celebrities and noted the eye colour of the celebrities, their confirmed romantic partners, and their parents. Interrater reliability across two raters (naïve research assistant) for celebrity (and partner/parent) eye colour selection was $\kappa = .480$, $p < .001$ for all eye colours, and $\kappa = .847$, $p < .001$ when split by light and dark, resulting in moderate to excellent agreement.

Results

Data Analysis Strategy

All analysis was carried out in R (R Development Core Team., 2008). First, we created a simulated permutation of the dataset: a version of the dataset where the data points, namely the partner eye colours, were randomly transposed, as described in Chapter 5. In the simulations, each participant retained the same number of partners (so a participant who listed the eye colours of three partners would still be listed next to the eye colours of three partners), and the total quantity of each eye colour remained the same (so if there were 500 blue-eyed partners listed in the original dataset, there would also be 500 blue-eyed partners listed in each simulated dataset). We created 100,000 such simulated datasets. Then, for each participant in every dataset, we calculated the proportion of partners whose eye colour matched the parent of the participant, or the participant themselves. Thus, a participant with a blue-eyed mother listed next to four partners (three blue-eyed and one brown-eyed), would have a score of .75; a participant who reported a brown-eyed parent and four partners (two blue-eyed and two brown-eyed), would have a score of .5; and a participant who had a green-eyed parent and one green-eyed partner, one brown-eyed partner, and one blue-eyed partner would have a score of .33. Finally, we used a paired-samples *t*-test to compare the proportion of matches in the real dataset to each of the 100,000 simulated datasets. As we had a directional hypothesis, we employed one-tailed testing. We report below the median

significance level and effect size using Cohen's *d* following Westfall (2016). We also analysed long-term and short-term relationships separately, following the same strategy. We ran the analyses both using the original eye colour terms, and then separately following categorisation of the eye colours into light (blue, blue/green, grey, green) or dark (black, dark brown, light brown, hazel) Little et al., (2003). The code and data are available here: https://osf.io/erp5n/?view_only=8ac96be24a4943e49d1a48dba3c6bd7a.

Analysis

Tables 18-37 (Appendix 4) show the results of the analyses performed, split by sample and the way eye colour was operationalised. Following Stulp, Buunk, Pollet, Nettle, & Verhulst (2013), we present the median *p*-value (one-tailed), median effect size, and the percentage of permutations where the original dataset had a significantly higher proportion of matches. Significant findings are presented in Table 18 and Table 19.

Results summary

Mother eye colour matching

When looking at both genders, the only evidence to support maternal eye colour matching comes from the 30-55-year-old sample, where we see small effects looking at all relationships and short-term relationships when categorised by all eye colours, and all relationships categorised as dark and light eye colour. This effect remains stable when looking at a White sample (see Table 18).

Female participants show some evidence for maternal matching only in the 30-55-year-old sample. We find small effects for all relationship types analysed by dark and light eye colour, and small effects for all relationships and short-term relationships categorised by all eye colours. This effect diminished in the White sample for short and long-term relationships, with only all relationships remaining stable.

When we look at the male participants' likelihood of maternal matching, we find no evidence in any age group. All effect sizes were minimal, with some hitting the small threshold. There were no significant effects in the White sample.

Father eye colour matching

When looking at both genders, we find evidence of paternal eye colour matching in the 30-55-year-old sample in all analyses, finding small effect sizes. We also see that student-centred short-term relationships categorised by all eye colours show evidence of paternal matching, again with a small effect size. These effects remain stable when looking at an all-white sample (see Table 18).

Female participants show some evidence of paternal matching only in the adult sample, in all relationships and short-term relationships categorised by all eye colours we find small effects, and also in all relationships categorised by dark and light colours. In the White sample, we find that this effect remains stable (See Table 18).

Male participants show some evidence of paternal matching: in the adult sample, we find small effects in all relationship types categorised by all colours, and long-term samples in dark and light eye colours. We also find one significant medium effect in the student sample, in short-term relationships categorised by all eye colours. Again, this effect remains the same in the White sample (See Table 18).

Self-Similar eye colour matching

When both genders were included in the analysis, we see small significant effects of self-similarity preferences in the 30-55-year-old samples, and one small but significant effect in the student-centred sample. This effect remains stable when looking at an all-White sample (See Table 19).

Females show self-similarity preferences in the student-centred sample, only in long-term relationships when eye colour is categorised as dark or light, and only in all relationships when eye colour is all colours in the 30-55-year-old sample. Both effects are small. This effect is removed in an all-White sample however.

Males show no significant effects of self-similarity preferences in any sample, regardless of ethnic makeup.

Table 18: White sample, parental eye colour matching, significant results only. See appendix 4 for all other results.

Sample	Sub-sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (p <.05, one-tailed)
Mother and whole sample	30-55 year olds	All colours	All relationships (1220)	$p < 0.01$ [< 0.01, 0.08]*	$d = 0.21$ [0.11, 0.32]	94%
			Short-term (678)	$p = 0.02$ [< 0.01, 0.24]*	$d = 0.18$ [0.06, 0.30]	69%
		Dark and light	All relationships (542)	$p = 0.03$ [< 0.01, 0.32]*	$d = 0.17$ [0.04, 0.30]	61%
Mothers and daughters	30-55 year olds	All colours	All relationships	$p < 0.01$ [< 0.01, 0.14]*	$d = 0.23$ [0.10, 0.37]	86%
		Dark and light	All relationships	$p = 0.02$ [< 0.01, 0.27]*	$d = 0.23$ [0.07, 0.40]	68%
Fathers and whole sample	student-centred	All colours	Short-term (347)	$p = 0.04$ [< 0.01, 0.31]*	$d = 0.18$ [0.05, 0.31]	56%
	30-55 year olds		All relationships	$p < 0.01$ [< 0.01, 0.02]*	$d = 0.25$ [0.15, 0.36]	99%
			Short-term	$p < 0.01$ [< 0.01, 0.04]*	$d = 0.27$ [0.16, 0.40]	98%
			Long-term (542)	$p = 0.04$ [< 0.01, 0.32]*	$d = 0.17$ [0.05, 0.31]	54%
		Dark and light	All relationships	$p < 0.01$ [< 0.01, 0.12]*	$d = 0.21$ [0.10, 0.33]	91%
			Short-term	$p = 0.03$ [< 0.01, 0.27]*	$d = 0.19$ [0.06, 0.32]	67%
			Long-term	$p = 0.04$ [< 0.01, 0.34]*	$d = 0.18$ [0.04, 0.33]	55%
Fathers and daughters	30-55 year olds	All colours	All relationships	$p = 0.01$ [< 0.01, 0.19]*	$d = 0.21$ [0.08, 0.33]	79%
			Short-term	$p = 0.02$ [< 0.01, 0.21]*	$d = 0.23$ [0.09, 0.38]	74%
Fathers and sons	student-centred		Short-term	$p = 0.03$ [< 0.01, 0.26]*	$d = 0.49$ [0.17, 0.86]	63%
Fathers and sons	30-55 year olds		All relationships	$p < 0.01$ [< 0.01, 0.12]*	$d = 0.33$ [0.15, 0.51]	89%
			Short-term	$p = 0.01$ [< 0.01, 0.16]*	$d = 0.35$ [0.15, 0.56]	82%
		Dark and light	All relationships	$p = 0.01$ [< 0.01, 0.21]*	$d = 0.28$ [0.10, 0.47]	80%

Table 19: White self-similarity preferences, significant results only. See appendix 4 for all other results.

Sample	Sub-sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Whole sample	Student-centred	Dark and light	Long-term (286)	$p = 0.03$ [< 0.01, 0.29]*	$d = 0.25$ [0.07, 0.43]	66%
	30-55 year old	All colours	All relationships (1199)	$p = 0.03$ [< 0.01, 0.29]*	$d = 0.25$ [0.07, 0.43]	66%
			Short-term (528)	$p = 0.03$ [< 0.01, 0.29]*	$d = 0.25$ [0.07, 0.43]	66%
Males	30-55 year olds	Dark and light	All relationships	$p = 0.04$ [< 0.01, 0.35]*	$d = 0.16$ [0.04, 0.28]	56%

Discussion

Previous research suggests that humans select partners with their opposite-sex parent's features, particularly eye colour. We investigate this phenomenon using lifetime romantic partners, as opposed to merely current partner or ideal partner, and use a mix of self-report and observational data.

Firstly, we find little evidence for a strong imprinting mechanism, and especially towards imprinting upon opposite-sex parents. Our results suggest that same-sex parent imprinting occurs, however, this is evident only in the 30-55-year-old sample. Previous work has found a mother's eye colour did not influence attractiveness judgements in female participants, but father eye colour did, or that the partner-sex parent's eye colour matches the partner (Bressan & Damian, 2018; Little et al., 2003; Saxton, 2016; Wilson & Barrett, 1987). In our data, however, women in the 30-55-year-old sample showed a consistent preference for partners with their mother's eye colour in both short and long-term relationship, but only short-term preferences with their father's eye colour. That is, among the 30-55-year-old sample, there were more women with partners whose eye colour matched the mother's eye colour than expected by chance. This is similar to the results in Chapter 5, in which the 30-55 year old group was the only sample to have any evidence for having consistent preferences for eye colour.

30-55-year-old men reported that their partners' eye colour matched their fathers', but not their mothers' eye colour, in both long and short-term relationships. This seemingly contradicts previous literature regarding partner-sex parent matching. In the student sample, young men did show a weak preference consistent with their father's eye colour in a short-term relationship, but no other evidence was found in the student sample or the celebrity sample as a whole, consistent with Chapter 5, where no consistent preferences were found in either the student or celebrity sample.

The fact that the data show matching effects only in the 30 – 55-year-old group could suggest that it takes time and experience to realise the matching preference, further

cementing the idea of a imprinting-like mechanism in humans, as imprinting is a time-sensitive mechanism in animals, generally the mechanism is present from infancy (Bateson, 1978). Similarly, we find little evidence to support parent-referential phenotyping, except for the 30-55-year-old group. Again, if this were a preference developed over time, we would expect similar results in the celebrity sample, as the mean age for that group was 38 years old, however, no effects were found.

Previous work has suggested individuals may have a self-similar preference (e.g., DeBruine, 2005; Kocsor et al., 2011; Lindova et al., 2016), an effect we find only in the 30-55 year old group. As with the parent-matching data however, we find no evidence of self-similarity preferences in celebrities.

There may be an issue between ideal eye colour in a partner, and the actualised partner. That is, if an individual finds a kind, hard-working and attractive partner, but they do not have the perfect eye colour, they will probably date them anyway. We had predicted that celebrities should be better placed than the other groups to realise their partner aspirations because they should have access to a larger pool, and in addition, our celebrity sample did not suffer from the potential recollection biases that could create false positives in our other samples, yet no effects were found. Accordingly, our overall pattern of results does not give us any particular confidence that there is good evidence for strongly consistent eye colour matching to parents across multiple relationships.

Using self-report measures is always open to criticism due to the potential for bias or misremembering information and thus future studies could endeavour to use photographs of their past partners. Participants did, however, report they were confident in their answers that could assist some of the problems with self-report. Additionally, the use of the celebrity sample minimises these problems, as there was no reliance on participant recollection. While we find no evidence supporting prior research, and in fact limited evidence towards same-sex matching, e.g. a daughter's boyfriend's eye colour matches her mother, a son's girlfriend's eye colour matches his father, we do find similar findings to Štěrbová et al., (2018) who also found evidence for same-sex matching in

eye colour. Both studies, however, have small effect sizes throughout, despite having real world data, rather than being lab-based, suggesting little real-world importance of parent-partner eye colour similarity. This is further emphasised when taking into account the results of Chapter 5, which found little evidence to support consistent eye colour preferences across multiple partners.

Chapter 7: General Discussion

Overview of studies

Human mate choice is an extraordinarily complex topic, with many unknown and interconnecting variables. Research on human mate choice is often rationalised on animal research, which results in controversial findings and is not necessarily transferable to humans, or based on subjective survey methods. This thesis aimed to answer several questions on this topic through an evolutionary lens and more objective measures, while adding novel and original work to the literature. A summary of the results from each experimental chapter follows, discussed as answers to the questions posed in chapter one.

Is a 'good' father identifiable through cues in his face?

Previous work has indicated that facial appearance can provide cues to mate value or likely behaviour. This seems to stem from the immunocompetence hypothesis, which postulates that testosterone enhances sexual characteristics while supressing the immune system, so that only males of high genetic quality can afford this extra stress (Folstad & Karter, 1992; Rantala et al., 2012; Roney et al., 2006). However, recently this has been heavily criticised (see chapter 1 for a more detailed discussion). In relation to behaviour, some research suggests that masculinity is not conducive to paternal tendencies, and that less masculine men are better at taking care of children, more trustworthy, reliable, and less selfish (Johnston et al., 2001; Kruger, 2006). In addition to masculine men being worse fathers, men with higher fWHR are perceived as less investing as fathers, more aggressive, and less faithful (Johnston et al., 2001). This essentially means that women may make a trade off - good genes, but poor fathering skills.

With this in mind, in Chapter 2 we set out to see if the quality of fathering, as judged by the father themselves, the daughter, and the mother, had a negative relationship with masculinity and fWHR. We predicted that the more masculine a father was, the worse he would be rated as a father. This was not in fact the case in our data. To recap, we measured two forms of structural masculinity: discriminant (the probability of each face being classified as male) and vector (placing each face on a continuum from female to male); each father's fWHR, and perceived masculinity, measured by raters. We found a medium strength relationship between discriminant masculinity and fathering score, in that more discriminately masculine men are rated as better fathers by themselves, his daughter, and the mother of his daughter. However, this was not the case for vector masculinity, perceived masculinity, nor fWHR.

Our findings potentially suggest that a trade-off between genetic quality and parental investment may not centre on perceived masculinity as previously thought, nor fWHR. Our results add to the literature arguing that women's trade-offs and the theory that masculine men make poorer parents are not as clear cut.

Do self-report and physiological measures of disgust show support for avoiding sexual contact with kin?

The Westermarck effect (Westermarck, 1903) describes an aversion to sexual contact with close kin, for example, those that brought them up, or siblings. Inbreeding costs are high, and thus it makes evolutionary sense to have mechanisms to avoid these costs. In research, self-similar faces have been used as a proxy for relatedness, which support the Westermarck effect. For example, facial resemblance increased perceived judgements of trustworthiness but reduced attractiveness (DeBruine, 2005), suggesting that resemblance increased kin-related altruism and trust judgements, but dampened sexual attraction, which has since been replicated successfully (Lindova et al., 2016; Zhuang et al., 2014).

In Chapter 3, we set out to investigate this further using different levels of self-similar morphed faces and ratings of sexual attraction, while also including a physiological

measure of disgust, facial EMG, which measured activity in the *levator labii superioris,* the muscle where the disgust response originates. We predicted that both self-report data and EMG data would show higher disgust the more self-similar the faces were. The self-report data suggested that participants found the idea of passionately kissing faces highest in resemblance to themselves was more disgusting than all other levels of similarity. The data from the forced choice pairs suggested that the 20% similar faces were selected as being the most preferred to be passionately kissed, followed by the original faces. The faces picked the least were those that were most similar. The physiological data was not predicted by level of similarity however, and only the 40% transformation showed significantly higher activation of the disgust reaction.

Our results partially support the literature surrounding the Westermarck effect. The self-report data clearly shows more disgust at higher levels of self-similarity, which we used as a proxy for relatedness. While the raw data showed activation of the disgust muscle increasing as transformation level increased, our physiological data did not seem to support this idea when tested using null-hypothesis significance testing.

Are couples identifiable through self-similar body language?

Chapter 1 covered the phenomenon of assortative mating in humans across three aspects: genetic similarity, physical similarity, and personality similarity, for which there is strong evidence in the literature. What is less known however is if couples have unconscious self-similar body language, do couples move the same? Chapter 4 acts as a pilot study that provides a detailed look at the concept of mimicry in body movement, but to summarise, research suggests that humans mimic each other to increase prosocial behaviour, closeness, and affiliation. We also tend to mimic more when there is a connection between ourselves and the person being mimicked, and less when the mimicked person is an out-group member, or when there is immediate dislike.

Based on this idea, in chapter 4, we used sophisticated motion capture technology to record naïve couples, and pairs of strangers interacting during a decision making task. The body movements were then turned into standardised avatars to avoid confounding

variables such as appearance and gender. We predicted that participants watching videos of the avatars interacting would be able to identify couples from strangers, based on their body language, which would have increased mimicry as compared to strangers.

Participants rated couples significantly more similar than strangers, and were marginally better at identifying couples than strangers. Word clouds and frequency analysis showed that the words most commonly used to describe couples included their closeness and mirroring behaviours, while strangers were described by distance and unease. Our data supported the idea that couples would act more similarly than strangers would, providing more support that pairs will mimic more when there is a connection, closeness, or affiliation with each other.

Finally, do individuals have a type in terms of preferences for eye colour, and is that type influenced by their parents via an imprinting-like mechanism, or a self-similar preference?

Chapters 5 and 6 explored the influence of parental and own appearance upon lifetime partner choice. To recap, work has found evidence to support an imprinting-like mechanism in humans, in that participants' partners often resemble their parent, seen in parent-similar race, age, height, WHR, breast size, and eye colour (e.g., Debruine et al., 2017; Jedlicka, 1980; Little et al., 2003; Seki et al., 2012; Valentova et al., 2017; Zei et al., 1981). These studies show support for the optimal outbreeding theory, in which the ideal partner is someone who is not so related that inbreeding costs are risked, but not so unrelated that they cannot survive in the given environment (Bateson, 1978, 1983; Bateson, 1980; Helgason et al., 2008). However, these studies tend to use ideal partner or current partner, which fails to give an overview of an individual's dating history. To combat this, and investigate trends amongst individuals' actualised partner choice, we asked participants for the eye colour of every single partner, their parents' eye colour, and their own eye colour.

In Chapter 5, we aimed to find out if individuals had a stable, realised preference for a particular eye colour in their partners. We find data suggesting that the student sample

and the 30-55 year old sample had consistent eye colour preferences in long-term relationships, although once all non-white participants were removed, only the older group remained statistically significant. This, and the fact that effect sizes were all minimal, leads to only limited support for consistent eye colour preference in partners.

Chapter 6 expanded this, by looking for patterns consistent with a parental imprinting-like mechanism, and a self-similar preference. We find limited support for parental imprinting upon eye colour, specifically in that only the 30-55 year old sample had same-sex parent eye colour preferences. This seemingly contradicts a lot of research, which states that either opposite-sex or partner-sex parent is the one that a preference forms for; however, we find evidence for same-sex parent matching. That is, among only the 30-55 year old sample, there were more women whose partners matched their mother's eye colour, than by chance, and similarly with men and their fathers.

Chapter 6 also investigated the potential for self-similarity preferences in line with assortative mating patterns. As with the parent-matching however, we find only limited evidence to support this in the 30-55 year old group.

Taken together, Chapters 5 and 6 suggest that an imprinting-like mechanism for eye colour in younger adults is not present in our sample, or may take some time to develop, which would explain the findings in the older adults who have had more time and possibly more partners to realise their preference (although this is not present in the celebrity sample). This also supports the idea that this eye colour preference is not imprinting as animals experience it from birth or infancy, but an analogous system that develops over time, if at all, given the small effect sizes across both studies. The same could be said about self-similar eye colour matching, not present in younger adults but indeed present in the 30-55 year old group. However, this effect, when present, is neither a strong nor consistent effect.

Study Limitations and future directions

There is an inherent problem with evolutionary work in mate choice in that typically it focuses on heterosexual participants, from WEIRD (Western, educated, industrialised, rich, demographic) samples, and like a lot of psychology research, is heavily made up of undergraduate students. This body of work also falls victim to those sampling problems, particularly by using solely WEIRD samples, and using undergraduate students in studies to an extent. However, an effort was made to recruit individuals outside of the typical undergraduate student, particularly in Chapters 5 and 6, wherein older adults were recruited in higher numbers than undergraduates. Using non-heterosexual participants is somewhat more difficult, when most hypotheses are based around heterosexual reproductive strategies. Future work should adjust hypotheses and samples to incorporate these under-researched groups. By conducting cross-cultural replications of the experiments conducted in this thesis, we will gain a clearer look at the role of culture on modern mate choice, rather than just mate choice in WEIRD samples, although this may be difficult for eye colour matching given that most non-white ethnicities have much less variation in eye colour.

A consistent problem with mate choice research is that the decision to date, sleep with, or marry another person is not made in a vacuum based on one specific trait. Evolutionary and social psychologists must therefore try to disentangle the many different confounding variables that factor into deciding upon a sexual partner. In this thesis, we look at individual factors: face shape, self-similarity in appearance, eye colour, and movement, and parental influences, all carefully controlled and isolated. It must be noted that there is a myriad of decisions when choosing a partner that were not covered in this thesis, for example, sexual chemistry, availability, or sense of humour, and in fact some decisions which may not be tangible (e.g. the feeling that person is the one), or the combination of any number of traits.

Methodologically, there are some issues with using photographs in research as we did in Chapters 2 and 3. Firstly, standardised photographs should be the goal in any study

analysing faces, which was achieved in Chapter 3 but not in Chapter 2. The reasons being that angles, lighting, background, and distance from camera can change the appearance of a person's face. The practicalities of participants' fathers coming into the lab to be photographed was unattainable for this body of work due to both time and budget constraints. However, should funding be available in the future to compensate fathers travelling to the lab to be photographed, this would be a helpful idea to add to the literature, and to see exactly how much difference there is between self-posed and standardised photographs.

Despite using standardised photographs in Chapter 3, there is still the fact that photographs are static, whereas we see the world in motion. This difference appears to affect ratings, as seeing someone dynamically move, talk, and gesticulate could increase (or decrease) sexual interest. For example, previous research has found that women are particularly responsive to male dynamic gestures (Roberts et al., 2009), which could be problematic when using static images. The ideal scenario would entail dynamic stimuli such as videos when asking participants to rate another person, even if the person is experimentally manipulated. With recent advances in technology, the ability to use videos of experimentally manipulated faces rather than static images would be a preferred method of garnering attractiveness ratings, for example Morrison, Clark, Tiddeman, & Penton-Voak (2010) used experimentally manipulated feminised and masculinised morphs using videos in attractiveness tasks. The authors concluded that using morphed videos is a valid way to manipulate facial shape, and recommend it for further use in the literature. In the same vein, one avenue for future research would be to immerse participants in a virtual reality world, with fully interactive, 1:1 scaled 3D models of avatars to be rated. Studies have shown that participants are fully immersed in the virtual world, in the consciousness, behavioural, and psychological sense (Gorini, Capideville, De Leo, Mantovani, & Riva, 2011; Waterworth, Riva, & Waterworth, 2003).

Some research has suggested that when interpreting women's attractiveness judgements of men, their menstrual cycle should be taken into account. This is based

upon the dual mating strategy hypothesis, which suggests that heterosexual women have stronger preferences for casual sex with men with more masculine faces during their high-fertility ovulatory phase, but prefer more feminine faces at other points in their cycle (e.g., Gildersleeve, Haselton, & Fales, 2014; Johnston et al., 2001; Pillsworth & Haselton, 2006). It might therefore, be pertinent for future ratings studies such as those in Chapters 2 and 3, to control for menstrual cycle. However, this topic has become controversial in the literature due to methodological concerns (e.g., small samples, between-subjects designs reducing power), and have since failed to replicate in more sound methodologies (see Jones, Hahn, & DeBruine, 2019 for a comprhensive review). The authors of this review suggest that instead of the dual mating strategy, women simply have increased sexual desire during particular phases of their menstrual cycle. The recently proposed oestrus model actually suggests that there are no predictions about changes in the type of man women are attracted to, regardless of their cycle (Gangestad & Thornhill, 2008; Roney, 2018; White, 2017), thus controlling for menstrual cycle may not be necessary.

Finally, there are critics of self-report designs, which was utilised in all five Chapters. Measures were taken to improve the reliability of each study however. In Chapter 2, fathers' self-reports were amalgamated with daughter and mother reports to avoid bias, and the three had high agreement in both directions: the poorer fathers admitted their faults, which matched the other reporters, and the better fathers were similarly backed up by the other reporters. Chapter 3 used self-reported feeling about passionately kissing different men, which was complimented by live EMG readings of the *levator labii superioris* muscles, the disgust muscle. Chapter 4 included having couples complete the Couple Satisfaction Index, a self-reported questionnaire regarding their feelings about their partner. While this was not necessarily controlled, partners' overall scores were in agreement. Finally, Chapters 5 and 6 included confidence ratings for each participant's self-report of their past partners' eye colours, which were on average, high. As an additional measure to combat the problems of self-report data, we included a celebrity

sample, which used observational data rather than self-report data. Future studies could use photographs to confirm past partner eye colour, but this then falls into the trap of standardised vs non-standardised photos, particularly in this age of digital photo manipulation.

Overall Conclusions

While mate choice does not happen in a vacuum, in a series of carefully controlled experiments, this thesis demonstrated extensions of existing hypotheses regarding imprinting and immunocompetence theory, and kick started new avenues of investigation, such as body language of romantic partners and using whole-life dating histories to investigate imprinting-like mechanisms, while using cutting-edge technology.

We found that masculine fathers are not worse fathers, and that perceived masculinity has no association with structural masculinity, that self-reported disgust supported the Westermarck hypothesis that cues of kinship are unattractive. We also found that couples move differently to strangers and can be identified as such, that individuals do not appear to actualise eye colour preference in dating partners, and that same-sex parent matching occurs more than opposite-sex parent eye colour matching, albeit in a weak effect.

This thesis applied novel, objective measures to a field usually restricted to survey designs, which adds a new level of reliability of information to the area of human mate choice. It is crucial that future studies replicate and extend the exciting findings of this thesis, particularly in terms of the objective measures, and it is hoped that they will pique the curiosity of evolutionary scholars, as the field of human mate choice and evolutionary psychology is merely on the precipice.

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Appendices

Appendix 1: Daughter version of Nurturant Fathering Scale

Appendix 2: Mother version of Nurturant Fathering Scale

Appendix 3: Original Nurturant Fathering Scale

Appendix 4: Tables 18- 35, additional analyses for Chapter 6

Appendix 1

Daughter version of Nurturant Fathering Scale

Please think about your childhood when you were growing up and rate each of the following items with respect to that time period.

1. How much do you think your father enjoyed being a father?
2. When you needed your father's support, was he there for you?
3. Did your father have enough energy to meet your needs?
4. Did you feel you could confide in (talk about important personal things with) your father?
5. Was your father available to spend time with you in activities?
6. How emotionally close were you to your father?
7. When you were a teenager, how well did you get along with your father?
8. Overall, how would you rate your father?
9. As he goes through his day, how much of a psychological presence do you think you have in your father's daily thoughts and feelings?

Appendix 2

Mother version of NFS

Please think about your daughter's childhood when she was growing up and rate each of the following items with respect to that time period

1. How much did her father enjoy being a father?
2. When your daughter needed support, was her father there for her?
3. Did her father have enough energy to meet your daughter's needs?
4. Did you feel that your daughter could confide in (talk about important personal things with) her father?
5. Was her father available to spend time with your daughter in activities?
6. How emotionally close was her father to your daughter?
7. When your daughter was a teenager, how well did her father get along with her?
8. Overall, how would you rate her father as a father?
9. As he goes through his day, how much of a psychological presence do you think your daughter has in her father's daily thoughts and feelings?

Appendix 3

Original NFS

Please think about your daughter's childhood when she was growing up and rate each of the following items with respect to that time period.

1. How much did you enjoy being a father?
2. When your daughter needed your support, were you there for her?
3. Did you have enough energy to meet your daughter's needs?
4. Did you feel that your daughter could confide in (talk about important personal things with) you?
5. Were you available to spend time with your daughter in activities?
6. How emotionally close were you to your daughter?
7. When your daughter was a teenager, how well did you get along with her?
8. Overall, how would you rate yourself as a father?
9. As you go through your day, how much of a psychological presence does your daughter have in your daily thoughts and feelings?

Table 20: Full results for whole sample and mother-matching eye colours

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed p-values [95% CIs]	Median d [95% Cis]	% significant (p <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.17 [0.01, 0.63]	*d* = 0.09 [0.01, 0.22]	14%
		Short-term	*p* = 0.20 [0.02, 0.68]	*d* = 0.09 [0.01, 0.24]	12%
		Long-term	*p* = 0.26 [0.02, 0.77]	*d* = 0.08 [0.01, 0.24]	7%
	Dark and light	All relationships	*p* = 0.51 [0.08, 0.92]	*d* = 0.05 [0.01, 0.18]	1%
		Short-term	*p* = 0.51 [0.09, 0.91]	*d* = 0.05 [0.01, 0.18]	< 1%
		Long-term	*p* = 0.55 [0.10, 0.94]	*d* = 0.06 [0.01, 0.21]	< 1%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.08]*****	*d* = 0.23 [0.12, 0.35]	95%
		Short-term	*p* = 0.01 [< 0.01, 0.17]*	*d* = 0.22 [0.10, 0.35]	80%
		Long-term	*p* = 0.08 [0.01, 0.46]	*d* = 0.17 [0.02, 0.33]	39%
	Dark and light	All relationships	*p* = 0.02 [< 0.01, 0.25]*	*d* = 0.20 [0.07, 0.34]	72%
		Short-term	*p* = 0.11 [< 0.01, 0.55]	*d* = 0.13 [0.01, 0.28]	26%
		Long-term	*p* = 0.08 [< 0.01, 0.46]	*d* = 0.17 [0.02, 0.33]	38%
Celebrity	All colours	All relationships	*p* = 0.50 [0.11, 0.91]	*d* = 0.05 [0.01, 0.16]	< 1%
		Short-term	*p* = 0.43 [0.07, 0.88]	*d* = 0.14 [0.01, 0.47]	1%
		Long-term	*p* = 0.30 [0.02, 0.78]	*d* = 0.19 [0.01, 0.61]	7%
	Dark and light	All relationships	*p* = 0.43 [0.07, 0.88]	*d* = 0.06 [0.01, 0.19]	2%
		Short-term	*p* = 0.62 [0.13, 0.96]	*d* = 0.17 [0.01, 0.57]	< 1%
		Long-term	*p* = 0.61 [0.13, 0.95]	*d* = 0.16 [0.01, 0.53]	< 1%

Table 21: Full results for mother and daughter's partner matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (p <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.15 [0.01, 0.60]	*d* = 0.11 [0.01, 0.26]	19%
		Short-term	*p* = 0.14 [0.01, 0.60]	*d* = 0.13 [0.01, 0.29]	20%
		Long-term	*p* = 0.31 [0.03, 0.81]	*d* = 0.08 [0.01, 0.26]	5%
	Dark and light	All relationships	*p* = 0.50 [0.08, 0.92]	*d* = 0.06 [0.01, 0.20]	1%
		Short-term	*p* = 0.53 [0.10, 0.92]	*d* = 0.06 [0.01, 0.20]	1%
		Long-term	*p* = 0.52 [0.09, 0.93]	*d* = 0.07 [0.01, 0.24]	< 1%
30-55 years old	All colours	All relationships	*p* = 0.01 [< 0.01, 0.16]*	*d* = 0.24 [0.10, 0.38]	83%
		Short-term	*p* = 0.05 [< 0.01, 0.36]*	*d* = 0.20 [0.05, 0.36]	49%
		Long-term	*p* = 0.10 [< 0.01, 0.50]	*d* = 0.17 [0.02, 0.36]	31%
	Dark and light	All relationships	*p* = 0.01 [< 0.01, 0.15]*	*d* = 0.30 [0.13, 0.47]	86%
		Short-term	*p* = 0.05 [< 0.01, 0.39]*	*d* = 0.22 [0.04, 0.41]	49%
		Long-term	*p* = 0.05 [< 0.01, 0.36]*	*d* = 0.25 [0.05, 0.45]	52%
Celebrity	All colours	All relationships	*p* = 0.50 [0.08, 0.90]	*d* = 0.08 [0.01, 0.27]	< 1%
		Short-term	*p* = 0.28 [0.12, 0.78]	*d* = 0.36 [0.01, 0.81]	***
		Long-term	*p* = 0.19 [0.04, 0.62]	*d* = 0.52 [0.03, 1.14]	3%
	Dark and light	All relationships	*p* = 0.48 [0.06, 0.92]	*d* = 0.10 [0.01, 0.32]	2%
		Short-term	*p* = 0.43 [0.10, 0.91]	*d* = 0.25 [0.01, 0.85]	< 1%
		Long-term	*p* = 0.20 [0.03, 0.75]	*d* = 0.46 [0.03, 1.37]	10%

Table 22: Full results for whole sample and father matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.07 [< 0.01, 0.43]	*d* = 0.15 [0.02, 0.28]	41%
		Short-term	*p* = 0.02 [< 0.01, 0.22]*	*d* = 0.22 [0.08, 0.37]	72%
		Long-term	*p* = 0.42 [0.05, 0.88]	*d* = 0.06 [0.01, 0.20]	2%
	Dark and light	All relationships	*p* = 0.20 [0.01, 0.71]	*d* = 0.09 [0.01, 0.25]	13%
		Short-term	*p* = 0.07 [< 0.01, 0.44]	*d* = 0.17 [0.03, 0.33]	42%
		Long-term	*p* = 0.53 [0.10, 0.93]	*d* = 0.06 [0.01, 0.21]	< 1%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.01]*	*d* = 0.31 [0.20, 0.42]	99%
		Short-term	*p* < 0.01 [< 0.01, 0.03]*	*d* = 0.31 [0.18, 0.44]	99%
		Long-term	*p* = 0.02 [< 0.01, 0.18]*	*d* = 0.24 [0.10, 0.38]	80%
	Dark and light	All relationships	*p* < 0.01 [< 0.01, 0.06]*	*d* = 0.27 [0.14, 0.40]	97%
		Short-term	*p* = 0.03 [< 0.01, 0.30]*	*d* = 0.20 [0.06, 0.35]	63%
		Long-term	*p* = 0.01 [< 0.01, 0.20]*	*d* = 0.25 [0.10, 0.41]	78%
Celebrity	All colours	All relationships	*p* = 0.55 [0.12, 0.92]	*d* = 0.05 [0.01, 0.15]	< 1%
		Short-term	*p* = 0.66 [0.08, 0.95]	*d* = 0.15 [0.01, 0.47]	1%
		Long-term	*p* = 0.41 [0.02, 0.87]	*d* = 0.15 [0.01, 0.54]	6%
	Dark and light	All relationships	*p* = 0.64 [0.16, 0.96]	*d* = 0.05 [0.01, 0.16]	< 1%
		Short-term	*p* = 0.48 [0.08, 0.93]	*d* = 0.13 [0.01, 0.42]	1%
		Long-term	*p* = 0.88 [0.42, 0.99]	*d* = 0.35 [0.03, 0.76]	< 1%

Table 23: Fathers and daughter's partners matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.19 [0.01, 0.66]	*d* = 0.10 [0.01, 0.25]	13%
		Short-term	*p* = 0.13 [0.01, 0.55]	*d* = 0.14 [0.01, 0.30]	21%
		Long-term	*p* = 0.47 [0.07, 0.90]	*d* = 0.06 [0.01, 0.22]	2%
	Dark and light	All relationships	*p* = 0.37 [0.04, 0.86]	*d* = 0.07 [0.01, 0.22]	3%
		Short-term	*p* = 0.18 [0.01, 0.67]	*d* = 0.12 [0.01, 0.29]	14%
		Long-term	*p* = 0.64 [0.15, 0.96]	*d* = 0.08 [0.01, 0.26]	< 1%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.08]*	*d* = 0.28 [0.15, 0.42]	95%
		Short-term	*p* < 0.01 [< 0.01, 0.12]*	*d* = 0.30 [0.14, 0.47]	89%
		Long-term	*p* = 0.07 [< 0.01, 0.41]	*d* = 0.20 [0.03, 0.38]	40%
	Dark and light	All relationships	*p* = 0.03 [< 0.01, 0.28]*	*d* = 0.24 [0.07, 0.41]	66%
		Short-term	*p* = 0.07 [< 0.01, 0.46]	*d* = 0.20 [0.03, 0.38]	38%
		Long-term	*p* = 0.07 [< 0.01, 0.43]	*d* = 0.22 [0.03, 0.42]	41%
Celebrity	All colours	All relationships	*p* = 0.59 [0.13, 0.93]	*d* = 0.09 [0.01, 0.28]	< 1%
		Short-term	*p* = 0.57 [0.06, 0.87]	*d* = 0.24 [0.01, 0.74]	< 1%
		Long-term	*p* = 0.46 [0.05, 0.90]	*d* = 0.26 [0.01, 0.81]	3%
	Dark and light	All relationships	*p* = 0.72 [0.18, 0.98]	*d* = 0.14 [0.01, 0.42]	< 1%
		Short-term	*p* = 0.34 [0.06, 0.78]	*d* = 0.28 [0.01, 0.90]	1%
		Long-term	*p* = 0.88 [0.41, 0.99]	*d* = 0.63 [0.04, 1.58]	***

Table 24: Mothers and sons partners matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.46 [0.07, 0.87]	*d* = 0.10 [0.01, 0.34]	1%
		Short-term	*p* = 0.56 [0.11, 0.91]	*d* = 0.12 [0.01, 0.40]	< 1%
		Long-term	*p* = 0.32 [0.02, 0.83]	*d* = 0.15 [0.01, 0.51]	7%
	Dark and light	All relationships	*p* = 0.48 [0.06, 0.91]	*d* = 0.11 [0.01, 0.38]	2%
		Short-term	*p* = 0.44 [0.07, 0.88]	*d* = 0.12 [0.01, 0.42]	1%
		Long-term	*p* = 0.54 [0.10, 0.93]	*d* = 0.13 [0.01, 0.43]	< 1%
30-55 years old	All colours	All relationships	*p* = 0.06 [0.01, 0.42]	*d* = 0.22 [0.03, 0.41]	43%
		Short-term	*p* = 0.07 [< 0.01, 0.40]	*d* = 0.26 [0.05, 0.48]	41%
		Long-term	*p* = 0.24 [0.02, 0.72]	*d* = 0.14 [0.01, 0.39]	9%
	Dark and light	All relationships	*p* = 0.43 [0.05, 0.91]	*d* = 0.08 [0.01, 0.27]	3%
		Short-term	*p* = 0.58 [0.13, 0.94]	*d* = 0.09 [0.01, 0.30]	< 1%
		Long-term	*p* = 0.45 [0.06, 0.90]	*d* = 0.10 [0.01, 0.33]	2%
Celebrity	All colours	All relationships	*p* = 0.54 [0.13, 0.91]	*d* = 0.06 [0.01, 0.21]	< 1%
		Short-term	*p* = 0.70 [0.05, 0.96]	*d* = 0.23 [0.01, 0.67]	2%
		Long-term	*p* = 0.50 [0.05, 0.89]	*d* = 0.18 [0.01, 0.63]	3%
	Dark and light	All relationships	*p* = 0.44 [0.08, 0.87]	*d* = 0.07 [0.01, 0.23]	1%
		Short-term	*p* = 0.64 [0.10, 0.96]	*d* = 0.22 [0.01, 0.74]	1%
		Long-term	*p* = 0.78 [0.27, 0.98]	*d* = 0.31 [0.02, 0.84]	< 1%

Table 25: Father and sons partner matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.06 [< 0.01, 0.40]	*d* = 0.33 [0.06, 0.64]	43%
		Short-term	*p* = 0.02 [< 0.01, 0.18]*	*d* = 0.56 [0.23, 0.93]	79%
		Long-term	*p* = 0.34 [0.01, 0.84]	*d* = 0.15 [0.01, 0.52]	8%
	Dark and light	All relationships	*p* = 0.09 [< 0.01, 0.54]	*d* = 0.28 [0.02, 0.60]	35%
		Short-term	*p* = 0.06 [< 0.01, 0.38]	*d* = 0.41 [0.08, 0.79]	46%
		Long-term	*p* = 0.27 [0.02, 0.76]	*d* = 0.18 [0.01, 0.56]	8%
30-55 years old	All colours	All relationships	*p* = 0.01 [< 0.01, 0.11]*	*d* = 0.35 [0.17, 0.55]	90%
		Short-term	*p* = 0.03 [< 0.01, 0.25]*	*d* = 0.32 [0.11, 0.54]	65%
		Long-term	*p* = 0.05 [< 0.01, 0.33]*	*d* = 0.31 [0.08, 0.55]	50%
	Dark and light	All relationships	*p* = 0.43 [0.05, 0.91]	*d* = 0.08 [0.01, 0.27]	3%
		Short-term	*p* = 0.14 [< 0.01, 0.60]	*d* = 0.18 [0.01, 0.42]	21%
		Long-term	*p* = 0.05 [< 0.01, 0.39]*	*d* = 0.30 [0.05, 0.57]	51%
Celebrity	All colours	All relationships	*p* = 0.50 [0.10, 0.89]	*d* = 0.05 [0.01, 0.18]	< 1%
		Short-term	*p* = 0.66 [0.08, 0.96]	*d* = 0.18 [0.01, 0.55]	< 1%
		Long-term	*p* = 0.38 [0.03, 0.83]	*d* = 0.19 [0.01, 0.70]	7%
	Dark and light	All relationships	*p* = 0.49 [0.10, 0.90]	*d* = 0.05 [0.01, 0.16]	< 1%
		Short-term	*p* = 0.77 [0.19, 0.98]	*d* = 0.23 [0.01, 0.61]	< 1%
		Long-term	*p* = 0.73 [0.20, 0.96]	*d* = 0.24 [0.01, 0.69]	< 1%

Table 26: Mothers and children (White participants only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.27 [0.02, 0.76]	*d* = 0.06 [0.01, 0.18]	7%
		Short-term	*p* = 0.26 [0.02, 0.75]	*d* = 0.07 [0.01, 0.20]	7%
		Long-term	*p* = 0.32 [0.03, 0.81]	*d* = 0.07 [0.01, 0.22]	5%
	Dark and light	All relationships	*p* = 0.48 [0.07, 0.91]	*d* = 0.05 [0.01, 0.17]	1%
		Short-term	*p* = 0.50 [0.09, 0.91]	*d* = 0.05 [0.01, 0.17]	< 1%
		Long-term	*p* = 0.50 [0.08, 0.91]	*d* = 0.06 [0.01, 0.20]	1%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.08]*	*d* = 0.21 [0.11, 0.32]	94%
		Short-term	*p* = 0.02 [< 0.01, 0.24]*	*d* = 0.18 [0.06, 0.30]	69%
		Long-term	*p* = 0.06 [< 0.01, 0.40]	*d* = 0.16 [0.03, 0.30]	45%
	Dark and light	All relationships	*p* = 0.03 [< 0.01, 0.32]*	*d* = 0.17 [0.04, 0.30]	61%
		Short-term	*p* = 0.19 [0.01, 0.68]	*d* = 0.09 [0.01, 0.23]	13%
		Long-term	*p* = 0.09 [< 0.01, 0.50]	*d* = 0.15 [0.02, 0.30]	34%

Table 27: Fathers and children (White participants only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.08 [< 0.01, 0.48]	*d* = 0.13 [0.01, 0.26]	35%
		Short-term	*p* = 0.04 [< 0.01, 0.31]*	*d* = 0.18 [0.05, 0.31]	56%
		Long-term	*p* = 0.40 [0.05, 0.87]	*d* = 0.06 [0.01, 0.20]	3%
	Dark and light	All relationships	*p* = 0.21 [0.01, 0.72]	*d* = 0.08 [0.01, 0.22]	12%
		Short-term	*p* = 0.15 [< 0.01, 0.62]	*d* = 0.11 [0.01, 0.25]	18%
		Long-term	*p* = 0.40 [0.05, 0.87]	*d* = 0.06 [0.01, 0.21]	2%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.02]*	*d* = 0.25 [0.15, 0.36]	99%
		Short-term	*p* < 0.01 [< 0.01, 0.04]*	*d* = 0.27 [0.16, 0.40]	98%
		Long-term	*p* = 0.04 [< 0.01, 0.32]*	*d* = 0.17 [0.05, 0.31]	54%
	Dark and light	All relationships	*p* < 0.01 [< 0.01, 0.12]*	*d* = 0.21 [0.10, 0.33]	91%
		Short-term	*p* = 0.03 [< 0.01, 0.27]*	*d* = 0.19 [0.06, 0.32]	67%
		Long-term	*p* = 0.04 [< 0.01, 0.34]*	*d* = 0.18 [0.04, 0.33]	55%

Table 28: Mothers and daughters (White only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.16 [< 0.01, 0.63]	*d* = 0.10 [0.01, 0.24]	17%
		Short-term	*p* = 0.17 [0.01, 0.64]	*d* = 0.11 [0.01, 0.26]	16%
		Long-term	*p* = 0.31 [0.03, 0.81]	*d* = 0.08 [0.01, 0.25]	5%
	Dark and light	All relationships	*p* = 0.58 [0.11, 0.95]	*d* = 0.06 [0.01, 0.20]	5%
		Short-term	*p* = 0.52 [0.09, 0.92]	*d* = 0.06 [0.01, 0.19]	< 1%
		Long-term	*p* = 0.59 [0.12, 0.95]	*d* = 0.07 [0.01, 0.24]	< 1%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.14]*	*d* = 0.23 [0.10, 0.37]	86%
		Short-term	*p* = 0.07 [< 0.01, 0.42]	*d* = 0.16 [0.03, 0.31]	40%
		Long-term	*p* = 0.06 [< 0.01, 0.41]	*d* = 0.19 [0.03, 0.37]	44%
	Dark and light	All relationships	*p* = 0.02 [< 0.01, 0.27]*	*d* = 0.23 [0.07, 0.40]	68%
		Short-term	*p* = 0.08 [< 0.01, 0.49]	*d* = 0.18 [0.02, 0.35]	35%
		Long-term	*p* = 0.09 [< 0.01, 0.49]	*d* = 0.19 [0.02, 0.38]	33%

Table 29: Fathers and daughters (White participants only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.17 [0.01, 0.64]	*d* = 0.10 [0.01, 0.24]	15%
		Short-term	*p* = 0.16 [0.01, 0.61]	*d* = 0.11 [0.01, 0.26]	16%
		Long-term	*p* = 0.41 [0.05, 0.87]	*d* = 0.06 [< 0.01, 0.22]	2%
	Dark and light	All relationships	*p* = 0.45 [0.06, 0.90]	*d* = 0.05 [< 0.01, 0.18]	2%
		Short-term	*p* = 0.26 [0.02, 0.76]	*d* = 0.08 [< 0.01, 0.23]	7%
		Long-term	*p* = 0.63 [0.14, 0.96]	*d* = 0.07 [< 0.01, 0.24]	< 1%
30-55 years old	All colours	All relationships	*p* = 0.01 [< 0.01, 0.19]*	*d* = 0.21 [0.08, 0.33]	79%
		Short-term	*p* = 0.02 [< 0.01, 0.21]*	*d* = 0.23 [0.09, 0.38]	74%
		Long-term	*p* = 0.14 [< 0.01, 0.58]	*d* = 0.13 [< 0.01, 0.30]	19%
	Dark and light	All relationships	*p* = 0.08 [< 0.01, 0.48]	*d* = 0.15 [0.02, 0.30]	36%
		Short-term	*p* = 0.12 [< 0.01, 0.55]	*d* = 0.14 [0.01, 0.31]	25%
		Long-term	*p* = 0.14 [< 0.01, 0.58]	*d* = 0.13 [< 0.01, 0.30]	19%

Table 30: Mothers and sons (White participants only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.67 [0.18, 0.95]	*d* = 0.12 [< 0.01, 0.37]	< 1%
		Short-term	*p* = 0.64 [0.17, 0.94]	*d* = 0.14 [< 0.01, 0.44]	< 1%
		Long-term	*p* = 0.45 [0.05, 0.90]	*d* = 0.12 [< 0.01, 0.42]	2%
	Dark and light	All relationships	*p* = 0.30 [0.02, 0.81]	*d* = 0.15 [< 0.01, 0.47]	7%
		Short-term	*p* = 0.45 [0.08, 0.88]	*d* = 0.12 [< 0.01, 0.40]	< 1%
		Long-term	*p* = 0.31 [0.03, 0.79]	*d* = 0.17 [< 0.01, 0.53]	5%
30-55 years old	All colours	All relationships	*p* = 0.11 [< 0.01, 0.55]	*d* = 0.16 [0.01, 0.35]	28%
		Short-term	*p* = 0.10 [< 0.01, 0.51]	*d* = 0.20 [0.02, 0.42]	29%
		Long-term	*p* = 0.31 [0.03, 0.79]	*d* = 0.10 [< 0.01, 0.33]	5%
	Dark and light	All relationships	*p* = 0.40 [0.04, 0.89]	*d* = 0.07 [< 0.01, 0.25]	3%
		Short-term	*p* = 0.67 [0.18, 0.96]	*d* = 0.10 [< 0.01, 0.31]	< 1%
		Long-term	*p* = 0.36 [0.03, 0.85]	*d* = 0.10 [< 0.01, 0.33]	4%

Table 31: Fathers and sons (White participants only)

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.11 [< 0.01, 0.53]	*d* = 0.27 [0.02, 0.58]	29%
		Short-term	*p* = 0.03 [< 0.01, 0.26]*	*d* = 0.49 [0.17, 0.86]	63%
		Long-term	*p* = 0.40 [0.02, 0.87]	*d* = 0.13 [< 0.01, 0.49]	6%
	Dark and light	All relationships	*p* = 0.07 [< 0.01, 0.49]	*d* = 0.31 [0.03, 0.65]	41%
		Short-term	*p* = 0.15 [< 0.01, 0.62]	*d* = 0.27 [0.02, 0.63]	19%
		Long-term	*p* = 0.10 [< 0.01, 0.52]	*d* = 0.35 [0.03, 0.75]	29%
30-55 years old	All colours	All relationships	*p* < 0.01 [< 0.01, 0.12]*	*d* = 0.33 [0.15, 0.51]	89%
		Short-term	*p* = 0.01 [< 0.01, 0.16]*	*d* = 0.35 [0.15, 0.56]	82%
		Long-term	*p* = 0.08 [< 0.01, 0.43]	*d* = 0.24 [0.04, 0.47]	33%
	Dark and light	All relationships	*p* = 0.01 [< 0.01, 0.21]*	*d* = 0.28 [0.10, 0.47]	80%
		Short-term	*p* = 0.07 [< 0.01, 0.45]	*d* = 0.24 [0.03, 0.46]	41%
		Long-term	*p* = 0.09 [< 0.01, 0.53]	*d* = 0.23 [0.02, 0.48]	32%

Table 32: Whole sample, self-similarity matching

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.20 [0.02, 0.67]	*d* = 0.08 [< 0.01, 0.21]	12%
		Short-term	*p* = 0.48 [0.09, 0.88]	*d* = 0.05 [< 0.01, 0.16]	< 1%
		Long-term	*p* = 0.15 [< 0.01, 0.64]	*d* = 0.12 [< 0.01, 0.29]	20%
	Dark and light	All relationships	*p* = 0.32 [0.03. 0.82]	*d* = 0.06 [< 0.01, 0.20]	5%
		Short-term	*p* = 0.77 [0.28, 0.98]	*d* = 0.09 [< 0.01, 0.24]	< 1%
		Long-term	*p* = 0.03 [< 0.01, 0.29]*	*d* = 0.25 [0.07, 0.43]	66%
30-55 years old	All colours	All relationships	*p* < 0.01, [< 0.01, 0.12]*	*d* = 0.20 [0.09, 0.31]	89%
		Short-term	*p* = 0.03 [< 0.01, 0.27]*	*d* = 0.18 [0.06, 0.30]	63%
		Long-term	*p* = 0.09 [< 0.01, 0.47]	*d* = 0.14 [0.02, 0.28]	31%
	Dark and light	All relationships	*p* = 0.02 [< 0.01, 0.25]*	*d* = 0.19 [0.06, 0.31]	71%
		Short-term	*p* = 0.12 [< 0.01, 0.56]	*d* = 0.12 [0.01, 0.26]	23%
		Long-term	*p* = 0.10 [< 0.01, 0.52]	*d* = 0.14 [0.01, 0.30]	29%
Celebrity	All colours	All relationships	*p* = 0.96 [0.70, 0.99]	*d* = 0.21 [0.06, 0.35]	*****
		Short-term	*p* = 0.49 [0.12, 0.92]	*d* = 0.13 [< 0.01, 0.41]	< 1%
		Long-term	*p* = 0.72 [0.20, 0.96]	*d* = 0.20 [0.01, 0.56]	< 1%
	Dark and light	All relationships	*p* = 0.60 [0.15, 0.95]	*d* = 0.06 [< 0.01, 0.20]	< 1%
		Short-term	*p* = 0.83 [0.37, 0.99]	*d* = 0.31 [0.02, 0.77]	****
		Long-term			

Table 33: Women and self-similarity preferences

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.27 [0.03, 0.78]	*d* = 0.07 [< 0.01, 0.20]	6%
		Short-term	*p* = 0.50 [0.10, 0.90]	*d* = 0.05 [< 0.01, 0.17]	< 1%
		Long-term	*p* = 0.19 [0.01, 0.68]	*d* = 0.12 [< 0.01, 0.30]	14%
	Dark and light	All relationships	*p* = 0.46 [0.07, 0.89]	*d* = 0.06 [< 0.01, 0.20]	1%
		Short-term	*p* = 0.85 [0.39, 0.99]	*d* = 0.13 [< 0.01, 0.30]	****
		Long-term	*p* = 0.04 [< 0.01, 0.35]*	*d* = 0.25 [0.06, 0.46]	55%
30-55 years old	All colours	All relationships	*p* = 0.03 [< 0.01, 0.25]*	*d* = 0.19 [0.06, 0.33]	68%
		Short-term	*p* = 0.09 [< 0.01, 0.46]	*d* = 0.16 [0.02, 0.32]	33%
		Long-term	*p* = 0.11 [< 0.01, 0.51]	*d* = 0.16 [0.02, 0.33]	27%
	Dark and light	All relationships	*p* = 0.10 [< 0.01, 0.48]	*d* = 0.15 [0.02, 0.30]	30%
		Short-term	*p* = 0.33 [0.04, 0.80]	*d* = 0.07 [< 0.01, 0.22]	3%
		Long-term	*p* = 0.08 [< 0.01, 0.46]	*d* = 0.19 [0.02, 0.38]	34%
Celebrity	All colours	All relationships	*p* = 0.92 [0.49, 0.99]	*d* = 0.26 [0.03, 0.52]	****
		Short-term	*p* = 0.40 [0.18, 0.90]	*d* = 0.26 [0.01, 0.54]	****
		Long-term	*p* = 0.86 [0.43, 0.97]	*d* = 0.56 [0.07, 1.25]	****
	Dark and light	All relationships	*p* = 0.55 [0.11, 0.94]	*d* = 0.10 [< 0.01, 0.33]	< 1%
		Short-term	*p* = 0.69 [0.21, 0.93]	*d* = 0.34 [0.01, 0.93]	****
		Long-term	*p* = 0.94 [0.61, 0.99]	*d* = 0.92 [0.15, 2.05]	****

Table 34: Men and self-similarity

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.24 [0.02, 0.74]	*d* = 0.15 [< 0.01, 0.43]	10%
		Short-term	*p* = 0.51 [0.10, 0.90]	*d* = 0.11 [< 0.01, 0.38]	< 1%
		Long-term	*p* = 0.26 [0.01, 0.80]	*d* = 0.17 [< 0.01, 0.55]	11%
	Dark and light	All relationships	*p* = 0.25 [0.01, 0.77]	*d* = 0.17 [< 0.01, 0.50]	10%
		Short-term	*p* = 0.39 [0.06, 0.86]	*d* = 0.13 [< 0.01, 0.45]	2%
		Long-term	*p* = 0.22 [0.02, 0.73]	*d* = 0.22 [0.01, 0.61]	10%
30-55 years old	All colours	All relationships	*p* = 0.08 [< 0.01, 0.44]	*d* = 0.20 [0.03, 0.39]	33%
		Short-term	*p* = 0.11 [< 0.01, 0.51]	*d* = 0.20 [0.02, 0.40]	23%
		Long-term	*p* = 0.28 [0.03, 0.75]	*d* = 0.12 [< 0.01, 0.35]	5%
	Dark and light	All relationships	*p* = 0.06 [< 0.01, 0.47]	*d* = 0.24 [0.03, 0.48]	45%
		Short-term	*p* = 0.11 [< 0.01, 0.55]	*d* = 0.23 [0.02, 0.48]	26%
		Long-term	*p* = 0.40 [0.05, 0.87]	*d* = 0.10 [< 0.01, 0.33]	3%
Celebrity	All colours	All relationships	*p* = 0.89 [0.52, 0.99]	*d* = 0.18 [0.02, 0.35]	****
		Short-term	*p* = 0.57 [0.12, 0.97]	*d* = 0.17 [< 0.01, 0.55]	< 1%
		Long-term	*p* = 0.48 [0.05, 0.87]	*d* = 0.17 [0.02, 0.63]	2%
	Dark and light	All relationships	*p* = 0.60 [0.16, 0.94]	*d* = 0.07 [< 0.01, 0.24]	< 1%
		Short-term	*p* = 0.83 [0.35, 0.98]	*d* = 0.35 [0.02, 0.92]	****
		Long-term	*p* = 0.41 [0.06, 0.83]	*d* = 0.17 [0.01, 0.57]	2%

Table 35: White females and self-similarity

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.16 [< 0.01, 0.61]	*d* = 0.11 [< 0.01, 0.25]	17%
		Short-term	*p* = 0.11 [< 0.01, 0.53]	*d* = 0.15 [0.01, 0.31]	27%
		Long-term	*p* = 0.77 [0.26, 0.98]	*d* = 0.12 [< 0.01, 0.32]	< 1%
	Dark and light	All relationships	*p* = 0.38 [0.05, 0.85]	*d* = 0.06 [< 0.01, 0.21]	2%
		Short-term	*p* = 0.14 [< 0.01, 0.59]	*d* = 0.14 [0.01, 0.31]	19%
		Long-term	*p* = 0.61 [0.14, 0.95]	*d* = 0.09 [< 0.01, 0.29]	< 1%
30-55 years old	All colours	All relationships	*p* = 0.07 [< 0.01, 0.44]	*d* = 0.14 [0.02, 0.27]	40%
		Short-term	*p* = 0.12 [< 0.01, 0.52]	*d* = 0.13 [0.01, 0.28]	23%
		Long-term	*p* = 0.21 [0.02, 0.69]	*d* = 0.10 [< 0.01, 0.26]	10%
	Dark and light	All relationships	*p* = 0.20 [0.02, 0.66]	*d* = 0.10 [< 0.01, 0.24]	11%
		Short-term	*p* = 0.38 [0.06, 0.83]	*d* = 0.06 [< 0.01, 0.20]	2%
		Long-term	*p* = 0.17 [0.01, 0.61]	*d* = 0.13 [< 0.01, 0.31]	15%

Table 36: White men and self-similarity

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.36 [0.04, 0.83]	*d* = 0.11 [< 0.01, 0.36]	3%
		Short-term	*p* = 0.51 [0.06, 0.92]	*d* = 0.13 [< 0.01, 0.42]	2%
		Long-term	*p* = 0.37 [0.03, 0.82]	*d* = 0.16 [< 0.01, 0.56]	5%
	Dark and light	All relationships	*p* = 0.35 [0.03, 0.85]	*d* = 0.14 [< 0.01, 0.45]	5%
		Short-term	*p* = 0.55 [0.11, 0.93]	*d* = 0.13 [< 0.01, 0.45]	< 1%
		Long-term	*p* = 0.13 [< 0.01, 0.54]	*d* = 0.39 [0.03, 0.86]	21%
30-55 years old	All colours	All relationships	*p* = 0.12 [< 0.01, 0.53]	*d* = 0.17 [0.02, 0.35]	24%
		Short-term	*p* = 0.12 [< 0.01, 0.52]	*d* = 0.19 [0.02, 0.40]	22%
		Long-term	*p* = 0.28 [0.04, 0.74]	*d* = 0.12 [< 0.01, 0.35]	4%
	Dark and light	All relationships	*p* = 0.06 [< 0.01, 0.45]*	*d* = 0.24 [0.03, 0.46]*	46%
		Short-term	*p* = 0.16 [< 0.01, 0.63]	*d* = 0.18 [0.01, 0.43]	18%
		Long-term	*p* = 0.21 [0.01, 0.70]	*d* = 0.16 [< 0.01, 0.43]	12%

Table 37: Entire white sample and self-similarity

Sample	Eye Colour Categorisation	Relationship type (total number of partners)	Median one-tailed *p*-values [95% CIs]	Median *d* [95% Cis]	% significant (*p* <.05, one-tailed)
Student-Centred	All colours	All relationships	*p* = 0.20 [0.01, 0.68]	*d* = 0.08 [< 0.01, 0.21]	12%
		Short-term	*p* = 0.48 [0.09, 0.88]	*d* = 0.05 [< 0.01, 0.16]	< 1%
		Long-term	*p* = 0.15 [< 0.01, 0.64]	*d* = 0.12 [< 0.01, 0.29]	20%
	Dark and light	All relationships	*p* = 0.33 [0.03, 0.82]	*d* = 0.06 [< 0.01, 0.20]	5%
		Short-term	*p* = 0.77 [0.27, 0.98]	*d* = 0.09 [< 0.01, 0.24]	< 1%
		Long-term	*p* = 0.03 [< 0.01, 0.29]*	*d* = 0.25 [0.07, 0.43]	66%
30-55 years old	All colours	All relationships	*p* = 0.03 [< 0.01, 0.29]*	*d* = 0.25 [0.07, 0.43]	66%
		Short-term	*p* = 0.03 [< 0.01, 0.29]*	*d* = 0.25 [0.07, 0.43]	66%
		Long-term	*p* = 0.16 [0.01, 0.60]	*d* = 0.10 [< 0.01, 0.23]	16%
	Dark and light	All relationships	*p* = 0.04 [< 0.01, 0.35]*	*d* = 0.16 [0.04, 0.28]	56%
		Short-term	*p* = 0.18 [0.01, 0.65]	*d* = 0.09 [< 0.01, 0.23]	14%
		Long-term	*p* = 0.09 [< 0.01, 0.48]*	*d* = 0.15 [0.02, 0.30]	32%